SOCIETAS CHIRURGICA AMERICANA
INSTITUTA D MDCCCLXXX

SHL
WITHDRAWN

TRANSACTIONS

OF THE

AMERICAN

SURGICAL ASSOCIATION.

VOLUME THE TWENTY-SECOND.

EDITED BY

RICHARD H. HARTE, M.D.,

RECORDER OF THE ASSOCIATION.

PRINTED FOR THE ASSOCIATION.

FOR SALE BY

WILLIAM J. DORNAN, PHILADELPHIA.

1904.

Copyright, 1904, by RICHARD H. HARTE, M.D., Recorder of the Association.

DORNAN, PRINTER,
701–709 ARCH STREET,
PHILADELPHIA.

CONTENTS.

PAGE

Officers of the Association v
List of Presidents of the Association vii
Fellows of the Association ix
Honorary Fellows xxiii
Report of the Committee on Necrology xxv

Address of the President. Antoine Francois Saugrain (de Vigni). By N. P. DANDRIDGE, M.D. 1
What Are the Minimum Requirements for Aseptic Surgical Operations? By GEORGE H. MONKS, M.D. 18
Minimum Requirements for Aseptic Surgical Operating in a Hospital in Which the Personnel of the Operating-room is Permanent. By A. J. OCHSNER, M.D. 28
Some Studies in Asepsis. By CHARLES HARRINGTON, M.D. 41
A Clinical Review of Forty-six Operated Cases of Duodenal Ulcer. By CHRISTOPHER GRAHAM, B.S., M.D., and WILLIAM J. MAYO, A.M., M.D. 58
Complete Removal of the Shaft of the Tibia for Osteomyelitis, with Restoration of the Bone. By GEORGE BEN JOHNSTON, M.D. 75
On Papillary Cysts and Papillary Tumors of the Ovaries in Consideration with Prognosis and Treatment. By PROFESSOR S. POZZI . . . 87
A Case of Acute Pancreatitis Associated with Gallstones. By JAMES BELL, M.D. 103
A Clinical and Experimental Study upon the Use of the Segmented Ring in Gastric and Intestinal Anastomoses. By FRANCIS B. HARRINGTON, M.D., and ALFRED H. GOULD, M.D. 111
The Treatment of Congenital Cleft Palate. A Plea for Operations in Early Infancy. By TRUMAN W. BROPHY, M.D., D.D.S. 124
The Evolution of Surgery. By J. EWING MEARS, M.D. 143
Gastrostomy in Œsophageal Stricture. By JAMES H. DUNN, M.D. . . 159
A Contribution to the Surgery of Nerves. The Bridging of Nerve Defects. By CHARLES A. POWERS, M.D. 173
Final Results in Secondary Sutures of Nerves. By EMMET RIXFORD, M.D. 186
Operations for Primary Carcinoma of the Liver. Report of a Case with Freedom from Recurrence at End of Sixteen Months. By LEONARD FREEMAN, M.D. 196

PAGE

Thyroidectomy for Exophthalmic Goitre. Based upon Forty Operated Cases. By C. H. MAYO, M.D. 210

Splenomegaly, Accessory Spleen and Splenectomy. By AUGUST FREDERICK JONAS, M.D. 220

Resection of Upper Jaws for Osteochondromyxosarcoma, with Osteoplastic Formation of New Hard Palate. By S. J. MIXTER, M.D. . . . 227

Gallstones in the Common Bile-duct. By STEPHEN H. WEEKS, M.D. . 232

A New Operation for Intestinal Stenosis, with Especial Reference to Colonic Cancer. By THEODORE A. MCGRAW, M.D. 241

Excision of the Clavicle. By N. B. CARSON, M.D. 248

The Subtle Power of Radium. By ROBERT ABBE, M.D. 253

A Case of Nephritis Treated by Decapsulation and Nephrotomy. By ALEXANDER HUGH FERGUSON, M.D. 263

On Certain Rare and Unavoidable Calamities following Surgical Operations. By MAURICE H. RICHARDSON, M.D. 273

An Interdental Adjustable Metallic Splint for the Treatment of Fracture of the Lower Jaw. With Report of Cases in Which it Has Been Applied by the Author. By RUDOLPH MATAS, M.D. 296

Ankylosis. Arthroplasty—Clinical and Experimental. By JOHN B. MURPHY, A.M., M.D. 315

New Aids to the Surgical Diagnosis of Diseases of the Kidneys and Their Value. By ARTHUR T. CABOT, M.D. 377

A Case of Splenectomy for Myelogenous Leukæmia. By MAURICE H. RICHARDSON, M.D. 386

OFFICERS OF THE ASSOCIATION,

ELECTED JUNE, 1904.

PRESIDENT.

GEORGE BEN JOHNSTON, M.D.

VICE-PRESIDENTS.

EMMET RIXFORD, M.D.,
JAMES BELL, M.D.

SECRETARY.

DUDLEY P. ALLEN, M.D.,
260 Euclid Ave., Cleveland.

TREASURER.

GEORGE RYERSON FOWLER, M.D.,
301 De Kalb Avenue, Brooklyn.

RECORDER.

RICHARD H. HARTE, M.D.,
1503 Spruce Street, Philadelphia.

COUNCIL.

DE FOREST WILLARD, M.D.,
MAURICE H. RICHARDSON, M.D.,
N. P. DANDRIDGE, M.D.,
GEORGE BEN JOHNSTON, M.D.,
DUDLEY P. ALLEN, M.D.,
GEORGE R. FOWLER, M.D.,
RICHARD H. HARTE, M.D.,
} *Ex-officio.*

PUBLICATION COMMITTEE.

RECORDER, SECRETARY AND TREASURER.

COMMITTEE ON ANNUAL MEETING.

A. J. OCHSNER, M.D. ROBERT ABBE, M.D.

PRESIDENT, SECRETARY, RECORDER AND THE CHAIRMAN OF THE COMMITTEE OF ARRANGEMENTS.

COMMITTEE ON NECROLOGY, CREATED IN 1884.

(Report by Title.)

F. H. GERRISH, M.D.,

N. B. CARSON, M.D.,

WM. L. RODMAN, M.D.

Place of next meeting:

SAN FRANCISCO, CAL., JULY 5, 6 and 7, 1905.

COMMITTEE OF ARRANGEMENTS.

THOS. W. HUNTINGTON, M.D.,

LEONARD FREEMAN, M.D.,

EMMET RIXFORD, M.D., *Chairman.*

CONGRESS OF TUBERCULOSIS, WASHINGTON, APRIL, 1905.

Delegates:

ROSWELL PARK, M.D., J. COLLINS, WARREN, M.D.,

GEORGE TULLY VAUGHAN, M.D.

CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS, WASHINGTON, 1907.

Delegate: W. W. KEEN, M.D.

Alternate: A. J. McCOSH, M.D.

LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION.

ELECTED

1880. †SAMUEL DAVID GROSS, M.D., LL.D., D.C.L. Oxon., LL.D. Cantab., LL.D. Edin.—Founder of the Association.
1883. †EDWARD MOTT MOORE, M.D., LL.D.
1884. †WILLIAM THOMPSON BRIGGS, M.D.
1885. †MOSES GUNN, A.M., M.D., LL.D.
1886. †HUNTER McGUIRE, M.D., LL.D.
1887. †D. HAYES AGNEW, M.D., LL.D.
1888. DAVID WILLIAMS CHEEVER, M.D., LL.D.
1889. †DAVID W. YANDELL, M.D.
1890. †CLAUDIUS HENRY MASTIN, M.D., LL.D.
1891. PHINEAS SANBORN CONNER, M.D., LL.D.
1892. NICHOLAS SENN, M.D., Ph.D., LL.D.
1893. J. EWING MEARS, A.M., M.D.
1894. FREDERIC SHEPARD DENNIS, M.D.
1895. LOUIS McLANE TIFFANY, A.M. Cantab., M.D.
1896. JOHN COLLINS WARREN, M.D., LL.D. (Jefferson), Hon. F.R.C.S. Eng.
1897. THEODORE F. PREWITT, M.D.
1898. WILLIAM W. KEEN, A.M., M.D., LL.D., Hon. F.R.C.S. Eng.
1899. ROBERT F. WEIR, A.M., M.D., F.R.C.S. Eng.
1900. ROSWELL PARK, M.D.
1901. DE FOREST WILLARD, A.M., M.D., Ph.D.
1902. MAURICE H. RICHARDSON, A.B., M.D.
1903. NATHANIEL P. DANDRIDGE, M.D.
1904. GEORGE BEN JOHNSTON, M.D.

† Deceased.

NOTICE.

THIS volume of TRANSACTIONS contains the papers read before the Association at the Meeting held June 14–17, 1904.

The Association assumes no responsibility for the statements and opinions published in this volume.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION.

JUNE, 1904.

* Denotes Original Fellows.

ELECTED

1890. ABBE, ROBERT, M.D., 13 West Fiftieth Street, New York. Surgeon to St. Luke's Hospital. *Vice-President*, 1901.

1894. ALLEN, DUDLEY P., A.M., M.D., *Secretary*, 260 Euclid Ave., Cleveland, Ohio. Professor of Surgery, Medical Department of Western Reserve University; Visiting Surgeon, Lakeside and Charity Hospitals; Consulting Surgeon to the Cleveland City Hospital.

1890. ALLIS, OSCAR HUNTINGTON, A.M., M.D., 1604 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital.

1902. ANDREWS, E. W., M.D., 2525 Prairie Avenue, Chicago, Ill.

1901. ARMSTRONG, GEORGE E., C.M., M.D., 320 Mountain Street, Montreal. Associate Professor of Clinical Surgery, McGill University; Surgeon to the Montreal General Hospital; Surgeon to the Western Hospital, Montreal.

1882. BARTON, JAMES M., A.M., M.D., 1337 Spruce Street, Philadelphia. Surgeon to the Jefferson Medical College Hospital and to the Philadelphia Hospital.

1901. BELL, JAMES, M.D., *Vice-President*, 873 Dorchester Street, Montreal. Professor of Clinical Surgery, McGill University; Surgeon to the Royal Victoria Hospital.

1900. BEVAN, ARTHUR DEAN, M.D., 100 State Street, Chicago. Associate Professor of Surgery, Rush Medical College, University of Chicago; Surgeon to Presbyterian Hospital.

ELECTED

1901. Binnie, J. F., M.B., C.M. (Aberdeen), Twelfth and Wyandotte Streets, Kansas City, Mo. Professor of Surgical Pathology and Clinical Surgery, Kansas City Medical College.

1902. Blake, Joseph A., M.D., 601 Madison Avenue, New York. Instructor in Surgery, Columbia University; Attending Surgeon to St. Luke's Hospital; Junior Surgeon to the Roosevelt Hospital; Consulting Surgeon to the Northern Dispensary.

1901. Bloodgood, Joseph C., B.S., M.D., 923 North Charles Street, Baltimore, Md. Associate in Surgery in the Johns Hopkins University.

1882. Bontecou, Reed Brockway, M.D., 82 Fourth Street, Troy, N. Y. Surgeon to the Marshall Infirmary.

1901. Bosher, Lewis C., M.D., 717 East Franklin Street, Richmond, Va. Professor of Surgery, Medical College of Virginia; Surgeon to the Old Dominion Hospital.

1890. Bradford, Edward Hickling, A.B., M.D., 133 Newbury Street, Boston. Surgeon to the Children's and the Samaritan Hospitals; Assistant Professor of Orthopedic Surgery in the Harvard University.

1900. Brewer, George Emerson, M.D., 68 West Forty-sixth Street, New York City. Junior Surgeon, Roosevelt Hospital; Attending Surgeon, City Hospital; Assistant Demonstrator of Anatomy in College of Physicians and Surgeons (Columbia University), New York.

*1880. Brinton, John H., M.D., 1423 Spruce Street, Philadelphia. Professor of the Practice of Surgery and of Clinical Surgery in the Jefferson Medical College; Surgeon to St. Joseph's Hospital. *Treasurer*, 1884–85.

1895. Bryant, Joseph D., M.D., 32 West Forty-eighth Street, New York. Professor of Anatomy and of Operative and Clinical Surgery, Bellevue Hospital Medical College; Surgeon to Bellevue and St. Vincent's Hospitals; Consulting Surgeon to Gouverneur Hospital, Hospital for Ruptured and Crippled, St. Joseph's and Hackensack Hospitals, Asylum for Insane, New York, etc.

1882. Bull, William Tillinghast, A.B., M.D., 35 West Thirty-fifth Street, New York. Adjunct Professor of the Practice of Surgery and of Clinical Surgery in the College of Physicians and Surgeons, New York; Surgeon to the New York and St. Luke's Hospitals; Consulting Surgeon to the Hospital for Ruptured and Crippled, and to the New York Cancer Hospital.

ELECTED

1900. Bunts, Frank E., M.D., 275 Prospect Street, Cleveland, Ohio. Professor of Principles of Surgery and Clinical Surgery in Medical College of Western Reserve University; Visiting Surgeon to St. Vincent's Charity Hospital; Consulting Surgeon to Cleveland City and Lutheran Hospitals.

1893. Burrell, Herbert Leslie, M.D. (Harvard), 22 Newbury Street, Boston, Mass. Assistant Professor of Surgery in Harvard University; Visiting Surgeon, Boston City Hospital; Visiting Surgeon to the Children's Hospital; Consulting Surgeon, Carney Hospital and the Quincy Hospital. *Secretary*, 1895–1901.

1889. Cabot, Arthur Tracy, A.M., M.D., 3 Marlborough Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

1885. Carmalt, William H., A.M., M.D., 87 Elm Street, New Haven, Conn. Professor of Surgery in Yale University; Surgeon to the New Haven Hospital. *Vice-President*, 1895.

1896. Carson, Norman Bruce, M.D., 3505 Olive Street, St. Louis, Mo. Professor of Clinical Surgery in the St. Louis Medical College; Surgeon to St. Louis and Mullanphy Hospitals and to the St. Vincent Insane Asylum, etc. *Vice-President*, 1903.

1882. Cheever, David Williams, M.D., LL.D., 557 Boylston Street, Boston, Mass. Professor of Surgery (Emeritus) in Harvard University; Surgeon to Boston City Hospital. *President*, 1888.

1896. Cole, Charles Knox, A.M., M.D., Helena, Montana. Surgeon to St. John's, St. Peter's, and County Hospitals.

1898. Coley, William B., M.D., 5 Park Avenue, New York. Attending Surgeon to the General Memorial Hospital; Associate Surgeon to the Hospital for Ruptured and Crippled, New York.

*1880. Conner, Phineas Sanborn, M.D., LL.D., 215 West Ninth Street, Cincinnati, Ohio. Professor of Surgery in the Medical College of Ohio; Emeritus Professor of Surgery, Dartmouth Medical College; Surgeon to the Cincinnati and the Good Samaritan Hospitals. *President*, 1891; *Member of Council*, 1883 and 1895–1900; *Treasurer*, 1885–91.

1896. Curtis, Benjamin Farquhar, A.B., M.D., 7 East Forty-first Street, New York. Professor of the Principles of Surgery and Clinical Surgery, University and Bellevue Hospital Medical College of New York; Attending Surgeon to St. Luke's and Bellevue Hospitals, and the General Memorial Hospital for Treatment of Cancer and Allied Diseases; Consulting Surgeon to New York Orthopedic Hospital and Dispensary.

ELECTED

1896. Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass. Junior Visiting Surgeon, Boston City Hospital; Assistant Surgeon, Children's Hospital, Boston.

1897. Da Costa, John Chalmers, M.D., 2045 Walnut Street, Philadelphia, Pa. Clinical Professor of Surgery, Jefferson Medical College; Surgeon to the Philadelphia and the Phœnixville Hospitals.

1883. Dandridge, Nathaniel Pendleton, M.D., 422 Broadway, Cincinnati, Ohio. Professor of Practice of Surgery and of Clinical Surgery in the Miami Medical College, Cincinnati. *President*, 1904. *Treasurer*, 1894–96. *Member of Council*, 1904.

1892. Deaver, John B., M.D., 1634 Walnut Street, Philadelphia. Surgeon-in-Chief to the German Hospital, Philadelphia.

1882. Dennis, Frederic Shepard, M.D., F.R.C.S. Eng., 542 Madison Avenue, New York. Professor of Clinical Surgery, Cornell University, New York City; Visiting Surgeon to the Bellevue and St. Vincent's Hospitals; Consulting Surgeon to St. Joseph's Hospital, Yonkers, and Montefiore Home, New York City. *President*, 1894; *Vice-President*, 1887; *Member of Council*, 1889.

†1899. Dunn, James H., M.D., 337 Oak Grove Street, Minneapolis, Minn. Professor of Practice of Surgery, Medical Department, University of Minnesota.

1901. Eliot, Ellsworth, Jr., M.D., 48 West Thirty-sixth Street, New York. Clinical Lecturer and Demonstrator of Surgery, College of Physicians and Surgeons, New York; Surgeon to the Presbyterian Hospital.

1893. Elliot, John Wheelock, A.M., M.D. (Harvard), 124 Beacon Street, Boston. Surgeon to Massachusetts General Hospital.

1896. Estes, William Lawrence, A.M., M.D., South Bethlehem, Pa. Director and Surgeon-in-Chief of St. Luke's Hospital; Lecturer on Hygiene at Lehigh University.

1898. Eve, Duncan, A.M., M.D., 700 Church Street, Nashville, Tenn. Professor of Surgery and Clinical Surgery, Medical Department, Vanderbilt University; Surgeon to the Nashville City Hospital.

1901. Ferguson, Alex. Hugh, C.M., M.D., 10 Drexel Square, Chicago, Ill. Professor of Clinical Surgery in the Medical Department of the University of the State of Illinois; Professor

† Deceased.

ELECTED

of Surgery in the Post-Graduate Medical School of Chicago; Surgeon-in-Chief of the Chicago Hospital; Surgeon to Cook County Hospital for the Insane; Consulting Surgeon to Provident Hospital.

1899. FINNEY, JOHN M. T., M.D., 1300 Eutaw Place, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

1882. FORBES, WILLIAM SMITH, M.D., 901 Pine Street, Philadelphia. Professor of Anatomy in the Jefferson Medical College of Philadelphia.

1891. FOWLER, GEORGE RYERSON, M.D., *Treasurer*, 301 De Kalb Avenue, Borough of Brooklyn, New York City. Professor of Surgery, New York Polyclinic; Examiner in Surgery, Medical Examining Board of Regents, University of State of New York; Surgeon to the Methodist Episcopal, German, and Brooklyn Hospitals; Consulting Surgeon to St. Mary's and Norwegian Relief (E. D.) Hospitals.

1904. FRAZIER, CHARLES HARRISON, M.D., 133 S. 18th Street, Philadelphia, Pa. Professor of Clinical Surgery, University of Pennsylvania; Surgeon to the University Hospital.

1898. FREEMAN, LEONARD, B.S., M.D., 1801 Franklin Street, Denver, Col. Professor of Surgery, Gross Medical College ; Surgeon to the Arapahoe County Hospital and to St. Anthony's Hospital.

1891. GASTON, JAMES MCFADDEN, A.B., M.D., 421 Capitol Avenue, Atlanta, Georgia. Professor of Surgery in Southern Medical College. *Vice-President*, 1897.

1882. GAY, GEORGE WASHINGTON, A.M., M.D., 665 Boylston Street, Boston, Mass. Senior Surgeon to the Boston City Hospital; Clinical Instructor in Surgery in Harvard University. *Member of Council*, 1882.

1892. GERRISH, FREDERIC HENRY, A.M., M.D., 675 Congress Street, Portland, Maine. Consulting Surgeon, Maine General Hospital; Professor of Anatomy in Medical Department of Bowdoin College.

1890. GERSTER, ARPAD G., M.D., Chir. D., 34 East Seventy-fifth Street, New York. Professor of Surgery in the New York Polyclinic; Surgeon to the German and Mount Sinai Hospitals.

1892. HALSTED, WILLIAM STEWART, B.A., M.D., 1201 Eutaw Place, Baltimore, Md. Surgeon to Johns Hopkins Hospital.

ELECTED

1898. HARRINGTON, FRANCIS B., A.B. (Tufts College), M.D. (Harvard College). 201 Beacon Street, Boston, Mass. Surgeon to Massachusetts General Hospital.

1900. HARRIS, MALCOLM L., M.D., 612 Reliance Building, Chicago, Ill. Professor of Surgery, Chicago Polyclinic; Attending Surgeon, Alexian Brothers' Hospital, St. Luke's Hospital, and Maurice Porter Hospital for Children.

1895. HARTE, RICHARD H., M.D., *Recorder*, 1503 Spruce Street, Philadelphia. Associate Professor of Surgery, University of Pennsylvania; Surgeon to the Pennsylvania Hospital and Orthopædic Hospital and Infirmary for Nervous Diseases; Consulting Surgeon to St. Mary's, St. Timothy's, and Bryn Mawr Hospitals.

1898. HEARN, W. JOSEPH, M.D., 1120 Walnut Street, Philadelphia. Clinical Professor of Surgery, Jefferson Medical College; Visiting Surgeon to the Philadelphia Hospital; Consulting Surgeon to the Phœnixville General Hospital.

1899. HORWITZ, ORVILLE, M.D., 1721 Walnut Street, Philadelphia. Clinical Professor of Genito-Urinary Diseases, Jefferson Medical College; Surgeon to the Philadelphia Hospital; Consulting Surgeon to State Hospital for Insane and Hayes Mechanics' Home.

1901. HUNTINGTON, THOMAS W., A.B., M.D., 1118 Sutter Street, San Francisco, California. Professor of Clinical and Operative Surgery, Medical Department, University of California; Visiting Surgeon to the City and County Hospital, San Francisco; Consulting Surgeon, St. Luke's Hospital, San Francisco.

1901. JACOBSON, NATHAN, M.D., 430 South Salina Street, Syracuse, N. Y. Professor of Clinical Surgery, College of Medicine, Syracuse University; Surgeon to St. Joseph's Hospital.

1901. JOHNSON, ALEXANDER B., M.D., 12 East Fifty-eighth Street, New York. Professor of Clinical Surgery, Cornell University Medical College; Attending Surgeon to New York Hospital.

1896. JOHNSTON, GEORGE BEN, M.D., *President*, 207 East Grace Street, Richmond, Va. Professor of the Practice of Surgery and of Clinical Surgery in the Medical College of Virginia; Surgeon to the Old Dominion Hospital, and Consulting Surgeon to the Richmond City Free Dispensary.

1901. JONAS, A. F., M.D., 106 South Thirty-first Avenue, Omaha, Nebraska. Professor of Surgery, Omaha Medical College;

ELECTED

Surgeon to the Methodist Episcopal Hospital and to the Douglas County Hospital.

1899. Kammerer, Frederick, M.D., 51 East Sixty-sixth Street, New York City. Professor of Clinical Surgery, Cornell Medical College; Surgeon to the German and St. Francis' Hospitals, New York.

*1880. Keen, William Williams, A.M., M.D., LL.D., Hon. F.R.C.S., Eng., 1729 Chestnut Street, Philadelphia. Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College; Surgeon to the Jefferson Medical College Hospital; Consulting Surgeon to the Woman's and St. Agnes' Hospitals; Membre Correspondant Etrangé de la Société de Chirurgie de Paris; Membre Honoraire de la Société Belge de Chirurgie. *President,* 1898; *Vice-President,* 1892; *Member of Council,* 1899–1901.

1901. La Garde, Louis A., M.D., United States Soldiers' Home, Washington, D. C. Professor of Military Surgery, New York University and Bellevue Hospital Medical College; Major and Surgeon United States Army.

1889. Lange, Frederick E., M.D., 691 Lexington Avenue, New York.

1901. Le Conte, Robert G., A.B., M.D., 1530 Locust Street, Philadelphia. Associate Professor of Surgery, University of Pennsylvania; Surgeon to the Pennsylvania, the Children's, and the Bryn Mawr Hospitals.

1903. Lutz, F. J., A.M., M.D., 1630 S. Grand Avenue, St. Louis, Mo. Professor of Surgery, Medical Department, St. Louis University; Surgeon-in-Chief, Alexian Brothers' Hospital; Surgeon-in-Charge, Josephine Hospital.

1901. McArthur, L. L., M.D., 4415 Drexel Building, Chicago, Ill. Professor of Clinical Surgery, Post-Graduate Medical School; Assistant Professor of Clinical Surgery, Rush Medical College; Surgeon to St. Luke's and Michael Reese Hospitals.

1896. McCosh, Andrew J., B.A., M.D., 16 East Fifty-fourth Street, New York. Surgeon to the Presbyterian Hospital; Clinical Lecturer on Surgery, College of Physicians and Surgeons.

1882. McGraw, Theodore A., M.D., 73 Case Street, Detroit, Michigan. Professor of Surgery in the Detroit Medical College; Surgeon to St. Mary's and Harper Hospitals. *Vice-President,* 1896.

ELECTED

1903. McMURTRY, LEWIS S., A.M., M.D., 1912 Sixth Street, Louisville, Ky. Professor of Gynecology and Abdominal Surgery, Hospital of Medicine, Louisville, Ky.

1901. MACDONALD, WILLIS G., M.D., 27 Eagle Street, Albany, New York.

1904. MACLAREN, ARCHIBALD, M.D., B.S., 350 St. Peter Street, St. Paul, Minn. Professor of Clinical Surgery, University of Minnesota.

1899. MARKOE, FRANCIS H., M.D., 15 East Forty-ninth Street, New York. Professor of Clinical Surgery, Medical Department, Columbia University, New York City; Attending Surgeon, St. Luke's and New York Hospitals; Consulting Surgeon, Orthopædic Hospital.

*1880. MARKS, SOLON, M.D., 136 Wisconsin Street, Milwaukee, Wis. Surgeon to St. Mary's Hospital. *Vice-President*, 1898.

1898. MARTIN, EDWARD, M.D., 1506 Locust Street, Philadelphia. Clinical Professor of Surgery, University of Pennsylvania; Clinical Professor of Surgery, Woman's Medical College, Philadelphia; Surgeon to Philadelphia, St. Agnes', and Howard Hospitals.

1887. MASTIN, WILLIAM MCDOWELL, M.D., Northeast corner of Joachim and Conti Streets, Mobile, Ala. Surgeon to the Mobile City Hospital.

1895. MATAS, RUDOLPH, M.D., 2255 St. Charles Avenue, New Orleans, La. Professor of Surgery, Medical Department, Tulane University; Professor of Clinical Surgery, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *Vice-President*, 1901.

1903. MAYO, CHARLES H., M.D., Rochester, Minn. Surgeon to St. Mary's Hospital.

1899. MAYO, WILLIAM J., A.M., M.D., 427 West College Street, Rochester, Minn. Surgeon to St. Mary's Hospital. *Vice-President*, 1903.

*1880. MEARS, J. EWING, A.M., M.D., 1535 Land Title Building, Philadelphia. *President*, 1893; *Recorder*, 1881–93.

1901. MEYER, WILLY, M.D., 700 Madison Avenue, New York. Professor of Surgery in the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the German and New York Skin and Cancer Hospitals; Consulting Surgeon to the New York Infirmary for Women and Children.

ELECTED

1893. Mixter, Samuel Jason, S.B. (Massachusetts Institute of Technology), M.D. (Harvard), 180 Marlborough Street, Boston. Surgeon to Massachusetts General Hospital and to Carney Hospital; Consulting Surgeon to the Massachusetts Charity Eye and Ear Infirmary; Instructor in Surgery in the Harvard University.

1896. Monks, George Howard, A.B. (Harvard), M.D. (Harvard), M.R.C.S. Eng., 67 Marlborough Street, Boston. Surgeon to Carney Hospital; Assistant Visiting Surgeon, Boston City Hospital; Instructor in Clinical and Assistant in Operative Surgery, Harvard Medical School; Instructor in Surgical Pathology, Harvard Dental School.

1895. Moore, James E., M.D., 802 Dayton Building, Minneapolis, Minn. Professor of Clinical Surgery, University of Minnesota; Surgeon to St. Barnabas' and Northwestern Hospitals; Consulting Surgeon to St. Mary's and City Hospitals.

1898. Morton, Thomas S. K., M.D., School Lane, Germantown, Philadelphia.

1904. Mudd, Harvey G., M.D., 2604 Locust Street, St. Louis, Mo. Professor of Fractures and Dislocations and Clinical Surgery, Medical Department, Washington University; Surgeon to St. Luke's Hospital; Consulting Surgeon to the St. Louis City Hospital.

1900. Munro, John C., M.D., 173 Beacon Street, Boston. Instructor in Surgery, Harvard; Professor of Surgery, Tufts College Dental School; Assistant Visiting Surgeon, Boston City Hospital.

1902. Murphy, John B., A.M., M.D., 100 State Street, Chicago, Ill. Professor of Surgery, Medical Department of Northwestern University, Chicago Post-Graduate School and Hospital, and Chicago Clinical School; Attending Surgeon to Mercy Hospital, Cook County Hospital, and Wesley Hospital; Consulting Surgeon to Alexian Brothers' Hospital and Hospital for Crippled Children.

1898. Murray, Francis W., M.D., 32 West Thirty-ninth Street, New York City. Professor of Clinical Surgery in Cornell University Medical College; Surgeon to the New York and St. Luke's Hospitals.

1882. Nancrede, Charles Beylard, A.M. (University of Pennsylvania), M.D., LL.D. (Jefferson), 720 South University Avenue, Ann Arbor, Mich. Professor of Surgery in the University of Michigan; Professor of Surgery, Dartmouth Medical College. *Vice-President*, 1889 and 1899.

ELECTED

1903. Neilson, Thomas R., M.D., 122 South Seventeenth Street, Philadelphia, Pa. Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children; Clinical Professor of Genito-Urinary Diseases in the University of Pennsylvania.

1900. Ochsner, A. J., B.S., F.R.M.S., M.D. Eng., 710 Sedgwick Street, Chicago. Professor of Clinical Surgery, College of Physicians and Surgeons; Surgeon-in-Chief of Augustana and St. Mary's Hospitals.

1900. Oliver, J. C., M.D., 628 Elm Street, Cincinnati, Ohio. Dean and Professor of Operative Surgery, Miami Medical College; Surgeon, Cincinnati, Presbyterian, and Christ Hospitals.

1882. Owens, John E., M.D., 1201 Venetian Building, Chicago, Ill. Professor of Principles and Practice of Surgery and Clinical Surgery in the Chicago Medical College; Surgeon to St. Luke's Hospital. *Vice-President*, 1900.

1899. Parham, Frederick William, M.D., 1429 Seventh Street, New Orleans, La. Professor of General Clinical and Operative Surgery on the Cadaver, New Orleans Polyclinic; Surgeon to Charity Hospital; Consulting Surgeon to Eye, Ear, Nose, and Throat Hospital.

1885. Park, Roswell, A.M., M.D., 510 Delaware Avenue, Buffalo, N. Y. Professor of Surgery in the Medical Department of the University of Buffalo; Surgeon to the Buffalo General Hospital; Consulting Surgeon to the Fitch Accident Hospital. *President*, 1900; *Vice-President*, 1893; *Member of Council*, 1893–94, 1901–03.

1893. Parmenter, John, M.D., 519 Franklin Street, Buffalo, N. Y. Professor of Anatomy and Clinical Surgery in the Medical Department of the University of Buffalo; Surgeon to the Sisters of Charity, Erie County, Fitch, Children's, and Emergency Hospitals; Assistant Surgeon to the Buffalo General Hospital.

1889. Pilcher, Lewis S., A.M., M.D., LL.D. (Dickinson), 145 Gates Avenue, Brooklyn, N. Y. Professor of Clinical Surgery in the Post-Graduate Medical School, New York; Surgeon to the Methodist Episcopal Hospital, New York. *Vice-President*, 1893.

1904. Porter, Charles Allen, A.M., M.D., 254 Beacon Street, Boston, Mass. Assistant Surgeon to the Massachusetts General Hospital; Instructor in Surgery, Harvard Medical School.

ELECTED

1887. Porter, Charles Burnham, A.M., M.D. (Harvard), 5 Arlington Street, Boston, Mass. Professor of Clinical Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *Vice-President*, 1892.

1882. Porter, William Gibbs, M.D., 1118 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital.

1896. Powers, Charles A., M.D., Fourteenth and Stout Streets, Denver, Col. Professor of Surgery in the University of Denver, and Surgeon to the Arapahoe County Hospital and to St. Luke's Hospital. *Vice-President*, 1903.

1882. Prewitt, Theodore F., M.D., 4917 Berlin Avenue, St. Louis, Mo. Professor of the Principles of Surgery in the Medical Department of Washington University; Surgeon to St. John's Hospital. *President*, 1897; *Vice-President*, 1886; *Member of Council*, 1894–96.

1886. Ransohoff, Joseph, M.D., F.R.C.S. Eng., 706 Walnut Street, Cincinnati, Ohio. Professor of Anatomy in the Medical College of Ohio; Surgeon to the Cincinnati and the Good Samaritan Hospitals.

1887. Richardson, Maurice Howe, A.B., M.D., 224 Beacon Street, Boston, Mass. Surgeon to the Massachusetts General Hospital; Assistant Professor of Clinical Surgery in Harvard University. *President*, 1902; *Vice-President*, 1897; *Secretary*, 1894–96; *Member of Council*, 1904.

1901. Rixford, Emmet, B.S., M.D., *Vice-President*, 1795 California Street, San Francisco, Cal. Professor of Surgery in Cooper Medical College; Surgeon to the City, County, and Lane Hospitals.

1882. Roberts, John B., A.M., M.D., 313 S. 17th Street, Philadelphia. Professor of Anatomy and Surgery in the Philadelphia Polyclinic; Surgeon to the Methodist and Jewish Hospitals. *Vice-President*, 1888 and 1894; *Treasurer*, 1892–93.

1898. Rodman, William L., A.M., M.D., 1904 Chestnut Street, Philadelphia. Professor of the Principles of Surgery and Clinical Professor of the Principles and Practice of Surgery and Clinical Surgery in the Woman's Medical College, Philadelphia; Professor of Surgery, Medico-Chirurgical College, Philadelphia.

1882. Rushmore, John Dikeman, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Surgery in the Long Island College Hospital; Surgeon to the Brooklyn, St. Peter's, and the Eye and Ear Hospitals.

ELECTED

1882. Senn, Nicholas, M.D., Ph.D., LL.D. (Jefferson), 532 Dearborn Avenue, Chicago, Ill. Professor of the Principles of Surgery and Clinical Surgery in Rush Medical College; Surgeon to Presbyterian Hospital; Surgeon-in-Chief to St. Joseph's Hospital. *President*, 1892; *Member of Council*, 1897.

1902. Shepherd, Francis J., M.D., 152 Mansfield Street, Montreal, Canada. Professor of Anatomy and Lecturer on Operative Surgery in McGill University, Montreal; Senior Surgeon to the Montreal General Hospital.

1895. Souchon, Edmond, M.D., 2403 St. Charles Avenue, New Orleans, La. Professor of Anatomy and of Clinical Surgery, Tulane University; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. *Vice-President*, 1899.

1900. Taylor, William J., M.D., 1825 Pine Street, Philadelphia. Surgeon to the Orthopædic Hospital and Infirmary for Nervous Diseases, and to St. Agnes' Hospital; Consulting Surgeon to the West Philadelphia Hospital for Women.

1885. Thompson, J. Ford, M.D., 1401 H Street, N. W., Washington, D. C. Professor of Surgery in the National Medical College; Surgeon to Garfield Memorial and Children's Hospitals.

1882. Thomson, William, M.D., 1426 Walnut Street, Philadelphia. Emeritus Professor of Ophthalmology in the Jefferson Medical College.

1882. Tiffany, Louis McLane, A.M. (Cantab.), M.D., 831 Park Avenue, Baltimore, Md. *President*, 1895; *Member of Council*, 1885–89, and 1896–97.

1882. Vander Veer, Albert, A.M., M.D., Ph.D., 28 Eagle Street, Albany, N. Y. Dean of Albany Medical College; Professor of Didactic Abdominal Surgery and of Clinical Surgery in the Albany Medical College; Consulting Surgeon to St. Peter's Hospital; Attending Surgeon to the Albany Hospital. *Vice-President*, 1898.

1902. Vaughan, George Tully, M.D., 1718 I Street, Washington, D. C. Professor of Principles and Practice of Surgery, Georgetown University; Professor of Surgery and Genito-Urinary Surgery, Washington Post-Graduate Medical School; Chief Surgeon, Georgetown University Hospital; Surgeon, Emergency Hospital; Consulting Surgeon, Government Hospital

ELECTED

for the Insane, Washington, D. C.; Assistant Surgeon-General, U. S. Public Health and Marine Hospital Service.

1891. WALKER, EDWARD W., M.D., 96 West Eighth Street, Cincinnati, Ohio. Professor of Surgery, Miami Medical College.

1882. WARREN, JOHN COLLINS, M.D., LL.D. (Jefferson), Hon. F.R.C.S. Eng., 58 Beacon Street, Boston, Mass. Professor of Surgery in Harvard University; Surgeon to the Massachusetts General Hospital. *President*, 1896; *Vice-President*, 1890; *Member of Council*, 1897.

1896. WATSON, FRANCIS SEDGWICK, A.B., M.D., 92 Marlborough Street, Boston. Surgeon to the Boston City Hospital; Instructor in Genito-Urinary Surgery, Harvard Medical School.

1889. WEEKS, STEPHEN H., M.D., 662 Congress Street, Portland, Maine. Professor of Surgery in the Medical School of Maine; Surgeon to Maine General Hospital. *Vice-President*, 1903; *Member of Council*, 1893.

1889. WEIR, ROBERT F., A.M., M.D., Hon. F.R.C.S. Eng., Cor. Mem. Surg. Soc., Paris, 11 East Fifty-fourth Street, New York. Professor of Surgery in the College of Physicians and Surgeons, Columbia University; Surgeon to the Roosevelt Hospital. *President*, 1899. *Member of Council*, 1893–1896, 1901–03.

1892. WHARTON, HENRY R., A.M., M.D., 1725 Spruce Street, Philadelphia. Surgeon to the Presbyterian, Children's, and Methodist Hospitals.

1882. WHITE, J. WILLIAM, M.D., Ph.D., 1810 South Rittenhouse Square, Philadelphia. John Rhea Barton Professor of Surgery in the University of Pennsylvania.

1882. WILLARD, DE FOREST, A.M., M.D. (Univ. of Pa.), Ph.D., 1818 Chestnut Street, Philadelphia. Professor of Orthopedic Surgery in the University of Pennsylvania; Surgeon to the Presbyterian Hospital; Consulting Surgeon to the Hospital for the Chronic Insane of Pennsylvania, to the New Jersey Training School, to the Germantown Hospital, the Atlantic City Hospital, Jewish Hospital, and the Phœnixville Hospital. *President*, 1901; *Recorder*, 1893–1900; *Member of Council*, 1901–04.

1901. WOOLSEY, GEORGE, M.D., 117 East Thirty-sixth Street, New York City. Professor of Anatomy and Clinical Surgery, Cornell University; Surgeon to Bellevue Hospital; Associate Surgeon to the Presbyterian Hospital.

HONORARY FELLOWS.

ELECTED

1885. ANNANDALE, THOMAS, M.R.C.S. Eng., M.D. Edin., 34 Charlotte Square, Edinburgh, Scotland. Regius Professor of Clinical Surgery in the University of Edinburgh.

1894. VON BERGMANN, PROF. DR. ERNST, Geh. Med. Rath., Klin. Institut für Chirurgie, Berlin, Germany.

1891. BRYANT, THOMAS, ESQ., F.R.C.S. Eng., 65 Grosvenor Street, Grosvenor Square, W., London.

1891. CHIENE, JOHN, F.R.C.S. Edin., M.D. Edin., 26 Charlotte Square, Edinburgh, Scotland. Professor of Surgery in the University of Edinburgh.

1885. CZERNY, PROF. DR. VINCENT, 25 Sophien Strasse, Heidelberg, Germany. Professor of Surgery in the University of Heidelberg.

1885. VON ESMARCH, PROF. DR. FRIEDRICH, 2 Hospitalberg, Kiel, Schleswig-Holstein, Germany. Professor of Surgery in the University of Kiel.

1893. GUSSENBAUER, PROF. DR. CARL, IX. Ferstelgasse, Vienna. Imperial and Royal Professor of Surgery and Chief of the Second Surgical Clinic and of the Surgical Institute.

1891. HARRISON, REGINALD, ESQ., F.R.C.S. Eng., 6 Lower Berkeley Street, Portman Square, W., London.

1890. HORSLEY, VICTOR ALEXANDER HADEN, F.R.C.S. Eng., 25 Cavendish Square, W., London.

*1883. HORWITZ, P. J., M.D., 1919 Walnut Street, Medical Director U. S. Navy (Retired), Philadelphia.

1894. KOCHER, PROF. DR. THEODOR, Professor of Surgery, University of Berne, 25 Villette, Berne, Switzerland.

* Deceased.

ELECTED

1885. Lister, Lord Joseph, F.R.C.S. Eng., D.C.L., LL.D., 12 Park Crescent, London, N. W. Professor of Clinical Surgery in King's College.

1894. Macewen, William, M.D., Mast. Surg., 3 Woodside Crescent, Glasgow, Scotland.

1903. Robson, A. W. Mayo, M.D., Leeds, England.

1882. Smith, Stephen, A.M., M.D., LL.D., 574 Madison Avenue, New York. Professor of Clinical Surgery in the University Medical College of New York; Surgeon to the Bellevue and the St. Vincent's Hospitals. *Vice-President*, 1890.

1896. Terrier, Dr. Felix, 11 Rue de Solférino, Paris, France. Professor of Operative Surgery in the Faculty of Medicine of Paris; Surgeon to the Hôpital Bichat.

REPORT OF THE COMMITTEE ON NECROLOGY.

JOHN ASHHURST, Jr., A.M., M.D., LL.D.

Born August 23, 1839. Died July 7, 1900.

Dr. Ashhurst was a native of Philadelphia, in which city his father was a successful merchant and banker. His mother's maiden name was Eyre, and from her he derived some of his most admirable qualities. In his childhood he was far from robust; and, indeed, throughout his life he found it necessary to observe strictly the rules of health; but he was rarely ill, and accomplished an amount of work which greatly exceeded that achieved by most men of pronounced sturdiness. His preparation for college was made at home, largely under the instruction of his mother; and, when only fourteen years old, he entered the University of Pennsylvania. Here he demonstrated his remarkable ability by attaining the highest rank ever taken by a student in the institution, and, at his graduation in 1857, he delivered the Greek oration. He immediately entered the medical department of the University, and received the doctorate in 1860.

His thesis on nervous action was thought worthy of publication by the faculty. For a year after graduation he was resident physician at the Pennsylvania Hospital. In the war of the rebellion he served as assistant surgeon in the Chester United States Army Hospital for fifteen months, and for two years as surgeon and executive officer in the Cuyler United States Army General Hospital in Germantown. From 1863 to 1880 he was attending surgeon to the Episcopal Hospital, and was afterward a member of its board of managers. In 1877 he was elected Professor of Clinical Surgery in the University of Pennsylvania, and Surgeon to the University Hospital, and he held these positions to the time of his death. In 1864 he married Miss Sarah Stokes Wayne, and the fruit of their union was three sons and four daughters. He was elected President of the College of Physicians in 1898.

In the midst of the arduous duties implied by the recital of these numerous and varied relations, he found time for a great deal of

literary work, as is seen by the mere mention of his principal publications. In 1865 his treatise on injuries of the spine was issued; he was the American editor of Erichsen's *Science and Art of Surgery* in 1869; in 1871 his work on the *Principles and Practice of Surgery* was published; he was editor of the *International Encyclopædia of Surgery*, 1881–1886, a work which was honored by translation into the French language; he also edited the first five volumes of the *Transactions of the College of Physicians*, and the *Transactions of the International Medical Congress* of 1876; he was a collaborator in the preparation of Lippincott's *Medical Dictionary*, 1897; he gave the address on Surgery before the Days of Anæsthesia, at the semi-centenary of the discovery of the surgical uses of ether at the Massachusetts General Hospital, in Boston, in 1896; and he wrote almost all of the surgical reviews in the *American Journal of the Medical Sciences* from 1867 to 1874. He did notable original work in the excision of joints, in the development of the pathology of cerebral and spinal concussion, and in the correction of facial deformities.

It is wonderful that he should have been able to achieve so many and so great results; but he seemed never to tire of work, always doing something with a definite and a good end in view. He allowed himself no vacations, finding his recreation in a change of activity. As a boy he showed precocity in his love of books, in his easy mastery of the piano, in his skill in the use of tools, in his intelligent collection of shells, minerals, and coins, and in his excellence in intellectual games.

In his professional life his taste for literature was displayed in the gathering of a large library, not only in line of his scientific labors, but also in the classics, in the French language, and in theology.

His great native ability was associated with a conscientiousness which ensured absolute thoroughness of performance in whatever he undertook; and thus he became a profound scholar in surgery, and so learned in the affairs of any institution with which he was connected that his superiority was promptly recognized, and his rightful leadership acknowledged. His writings are characterized by clearness, accuracy, and compactness. As a lecturer he strove for precision and thoroughness, never for brilliant rhetorical display. He was considered a severe examiner; but he rightly felt that a great responsibility rests upon those who sanction the admission of men to the medical profession. He exacted from others nothing that he was not willing to have required of himself. As an operator he was deliberate, cool, and careful, doing nothing for ostentation, and making the welfare of his patient the constant object of his efforts. To the casual observer his manner seemed distant; but his relations to those with whom he was closely

associated were remarkably agreeable. He was a true friend, and, as such, he was valued by all who obtained admission to his intimacy.

In July, 1900, a cerebral hemorrhage paralyzed his left side, and put an end to the activities of his busy life. His intellect, however, remained unclouded, and he had a full appreciation of his condition during the two years that remained to him. Hard as it was for him to endure this enforced and hopeless idleness, he uttered no word of complaint, but showed the utmost fortitude in his affliction. His faith in the future life never wavered; and, when the last hour came, he passed peacefully away, leaving a record of native ability, phenomenal industry, remarkable achievement, and purity of character which is worthy of the highest admiration.

LEVI COOPER LANE, M.D., A.M., LL.D.

Born May 9, 1830. Died February 18, 1902.

Dr. Lane was born on a farm thirty-four miles north of Cincinnati, Ohio. His father was Ira Lane; his mother, Hannah Cooper—both descended from orthodox Quaker stock. Until he was sixteen years old he worked on the farm and attended district school. Then he taught school three years. He was ambitious for a collegiate education, and, after a six months' course at Cary's Academy, he entered Union College, at Schenectady, N. Y. His means were so scanty, however, that he was obliged to board himself, and did this on twenty-five cents a week. A half-year of college was all that he could get, and thus ended his preparation for medical study. But it is pleasant to know that Union College years afterward showed its appreciation of his profound learning and great intellectual attainments by making him Master of Arts, and in 1877 conferring on him the honorary degree of Doctor of Laws—the highest distinction which a college can bestow. Two of his maternal uncles were physicians, and with them he read medicine, after the custom of those days. He had a year's instruction at the Jefferson Medical College, in Philadelphia, and was graduated in 1851. He received an appointment as interne in the New York State Hospital, on Ward's Island, and kept it for four years. Then he entered the medical corps of the United States Navy, winning his place by the manifest superiority which he displayed in a competitive examination, in which he had many rivals. His duties took him into many parts of the world, and he thus had fine opportunities to enlarge his views and increase his store of information. He was an indefatigable worker, constantly studying, not merely in the line of his professional aspirations, but also in literature and language; and, as a result, he attained familiarity with Greek and Latin, and the best of the classic writings, was able to speak French and German fluently, and had a good working knowledge of Spanish and Italian. In 1861 he resigned from the navy to associate himself with his uncle, Dr. Elias S. Cooper, who had established in San Francisco three years previously the first medical school on our western coast (the University of the Pacific), and was the leading spirit of the profession of California. From 1875 to 1877 Dr. Lane was in Europe, striving to perfect himself, and was admitted to membership in the Royal College of Surgeons of England. He also received the degree of Doctor of Medicine from the University of Berlin. In 1880 he began the erection of the Cooper Medical College, named

by him in honor of his uncle, whose memory he always revered. In 1894 he built the Lane Hospital, and in 1896 founded and endowed the Lane Course of Medical Lectures—a series of discourses given annually by some medical man, eminent for his learning and skill in some special branch of medicine. He projected an elaborate work on the surgery of the entire body; but he was able to prepare only one volume of it, that on the head and neck. This volume will remain as a monument to his ability and diligence.

Dr. Lane was very happy in his married life, but he had no children. In his last few years his strength gradually failed, and he fully recognized that his capacity for work steadily diminished. His mind remained clear to the very last, and he watched the progress of his decline with philosophic composure. He had achieved wonderful success, he had won the respect of his colleagues and of the community, and he was content. Soon after his death memorial services were held in Lane Hall of the Cooper Medical College, and eulogies were pronounced by several of his associates, and representatives of the alumni and undergraduate body. These tributes to the dead surgeon were full of admiration and regard, and bore eloquent testimony to his sterling qualities. His scholarship, thoroughness, modesty, skill, courage, and dignity were rehearsed with enthusiasm; but the greatest emphasis was laid on his personality—superficially austere, but deeply full of affection—his unswerving loyalty, his generous philanthropy, and the sturdy uprightness of his character. There was entire agreement in the feeling of irreparable loss, and of gratitude for the noble life which had, for so many years, shed its beneficence upon all who came within the sphere of its influence.

JAMES HENRY DUNN, M.D.

Born May 29, 1853. Died June 16, 1904.

Dr. Dunn was born at Fort Wayne, Indiana, of Irish parents. When he was six years old he lost his father, and was given a home by a farmer in Winona County, Minnesota, and there he remained until he was fifteen years of age. From that time he supported himself, at first by manual labor. His earnings were devoted, as far as possible, to the procurement of an education. He had two years of instruction in the High School and then took the course of the Winona State Normal School, from which he was graduated in 1873. In his vacations he taught in summer schools, and for several years took a prominent part in the work of the Minnesota State Teachers' Institute. In 1875 he began the study of medicine, and received the doctorate from the University of the City of New York three years later. He then had the professorship of the natural sciences in the Mankato State Normal School until 1880, when he began the practice of medicine in Shakopee, Minnesota, succeeding from the start. In three years he had accumulated enough money to enable him to go abroad, where he studied for two years, chiefly in Vienna and Heidelberg. On returning to America he settled in Minneapolis, which thenceforward was his home. He was at once made Professor of Genito-Urinary Diseases in the Minnesota Hospital Medical College, and when this institution became the Medical Department of the University of Minnesota, he continued in the same chair. In 1901 he was made Professor of Surgery. In 1888 he was chosen President of the Minnesota State Medical Association, and in 1902 Vice-President of the American Medical Association. During his attendance at the last meeting of the American Surgical Association he was taken suddenly ill, and died at his hotel in St. Louis.

Dr. Dunn's career was really remarkable. His health was never good; he never felt thoroughly well a day at a time; but his ambition and dauntless will were so great that he constantly worked to the very limit of his powers. His youth was an incessant struggle for an education. Unflagging industry, intelligently directed to a worthy end; a tenacious memory, and the capacity to recognize the logical relations of facts; absorbing interest in his work, whatever it was; a standard of morals of the highest type; and a personality which charmed all with whom he came in contact—these were attributes which made him a ripe

scholar, a learned diagnostician, a skilful operator, a most popular and successful practitioner, and a beloved friend. He was generous to his fellows, delighted in their deserved successes, and stood ever ready to give needed aid. His relations to the community, to the profession, and to his family were exemplary. His death is felt as a keen and irreparable loss, not only by his immediate family, but by a large circle of friends, who will ever cherish his memory with sincerity and tenderness.

DR. ANTOINE FRANÇOIS SAUGRAIN

(*From an oil portrait, painted from life.*)

ADDRESS OF THE PRESIDENT.

ANTOINE FRANCOIS SAUGRAIN (DE VIGNI).

By N. P. DANDRIDGE, M.D.,
CINCINNATI, OHIO.

I DESIRE in the first place to express to the Fellows of the Association my high appreciation of the honor conferred upon me in being called to preside at this meeting—an honor I feel I have hardly earned by the contributions I have made to the work of the society.

In presenting my address, which custom has made one of the duties of the presiding officer, I shall depart somewhat from the practice of my predecessors, and instead of bringing before you some medical question based on my own work, or attempting a discussion of some topic now of active interest, I shall take you into the backwoods and try and interest you in the life and exploits of a pioneer doctor—a life whose fine moral and intellectual fibre, I venture to assert, has much that is worthy of our consideration and respect.

I shall not be able to point out any such monumental work as was left behind by Daniel Drake in his *Diseases of the Mississippi Valley*. Indeed, I shall have little to tell that is strictly medical or surgical history, but I hope to depict one of high scientific attainments and true culture with all the elements of character which become the doctor and the man. Our wandering course will be a long one, and you will find yourself far afield as we cross over mountains and through the wilderness, and float down rivers whose banks conceal the danger of ever-hostile Indians,

until at last our winding way will lead to the small French village of St. Louis under its last French Governor, Zenon Trudeau. The courage of our hero in danger, his resourcefulness in difficulties, and his unfailing amiability and sweetness of character made him beloved by all who came in contact with him, and make him a worthy predecessor of the great profession of this great city—a worthy son of France, the great country which gave him birth, and certainly entitle him to a place as *bon-camarade* among the Fellows of the Surgical Association.

My information upon the subject of my sketch has been largely obtained from a paper by Eugene Bliss, of Cincinnati, presented to the American Antiquarian Society, and from the collection of papers relating to the settlement of Gallipolis, collected and arranged by John M. Newton, and now in the Cincinnati Historical Society, and a pamphlet on the first "Scientist of the Mississippi Valley," by W. V. Byars. From all of these I have freely drawn.

Antoine François Saugrain de Vigni was born in Paris, February 17, 1763. He came from a long line of "librarians, booksellers, and printers," who, as far back as Charles IX. in Lyons and Henry of Navarre, had served the royal family of France. The de Vigni, which was but occasionally used, seems to be explained from the custom at that time in vogue in Paris of sending children to nurse into the country, and on their return they were known by the name of the village in which they had lived. Little is known of his early life, but it is evident he was given a thorough general scientific education, and that he studied "chemistry, mineralogy, and physic." His general scientific knowledge stood him in good stead in the wilderness, and he was ever ready to put it to the most practical use in his daily wants. His knowledge of mineralogy made his advice often called for in the development of the mines in the Ohio Valley. He supplied himself with ink in the wilderness from a natural chalybeate water and an infusion of white oak bark, and when in need of a fire lighted it from a lens made by two watch crystals, with clear water between.

Wherever he found himself he established furnaces and chemical laboratories and had his electric batteries, and in time of leisure he made thermometers and barometers, which he readily sold. He was most observant of the resources of the country and its inhabitants, and has left acute comments on both. He probably never practised in Paris, for about the time his studies were completed his family, who were royalists, were compelled to flee across the Rhine, and for a time he did not know their whereabouts. Learning of a party of French coming to America, he joined them, and seems to have entered the service of the King of Spain, for we soon find him engaged in mineralogical investigations in Mexico, the friend of the Viceroy, Don Galvez. This Viceroy Humboldt calls "the enlightened Galvez." After his death Saugrain returned to France, but was never afterward able to shake himself free from the attraction which the life in the wilds possessed for him. In 1787 we learn from Brissot de Warville that Saugrain again came to America with a M. Piquet, a French philosopher, fully imbued with the ideas of Rousseau, then in vogue, on the "Rights of Man," and who believed in "the primitive innocence and goodness of the children of the forest." The two dined the night before they left Paris with Dr. Guillotin, who had married Saugrain's sister, and who at that time was undisturbed by his future celebrity. Piquet was a botanist, and Kentucky and the valley of the Ohio were their objective points for the purpose of studying the flora and probably also to ascertain the feasibility for a French colony. They reached Fort Pitt too late to go down the river, and "established themselves in an abandoned cabin a few miles away." They suffered greatly from the cold, and lived principally on "venison and potatoes." In spite of their hardships they busied themselves with their scientific work. Saugrain examined mines in the neighborhood, and found iron, lead, copper, and silver. With his hydrostatic scales he determined the weight and density of the various kinds of wood and tested their capacity for the production of potash; cornstalk he found the richest. March 19, 1788, the two set out down the Ohio. Piquet did not find that his humanitarian

views of the Indians worked out in actual practice, for they soon killed and scalped him. Dr. Saugrain has left a record of the trip.

Translation by Eugene Bliss of the "Relation of a Trip Down the Ohio River."

"My Friends: The ice having caught us at Pittsburg, you know that we were obliged to remain there the space of four months, and that in the end, the Ohio having opened, we saw with regret our first boat depart, carried away by the ice. We had another one made, in which we embarked to the number of four, to wit: M. Piquet and Raguet (French), Pierce (American), and myself. We set out from Pittsburg March 19, 1788. We stopped at Wheeling (Woulige) and at Muskingum, and at Limestone (now Maysville), a place where a fine town should be built; in short we continued our voyage without accident until the 24th, always admiring both banks of the Ohio, which in places are magnificent. But on the 24th, at half-past four in the afternoon, being nearly opposite the Big Miami, as the wind had thrown us a little upon the shore of the Ohio, on the Pennsylvania side, and while we were preparing to put ourselves rather more out in the current to go faster, M. Piquet called my attention to a flat-boat which was upon the same bank. Alas! he was far from thinking this same boat would cause his death. As we were getting away from the shore mentioned to gain the stream, we heard ourselves called by the Indians, who at the same time fired upon us. At the first shot they killed my mare, and in struggling the poor creature pushed against M. Piquet's, which gave me a kick in the belly, throwing me flat, and with another she would certainly have killed me had she struck me, but she only grazed the skin on my forehead. As the mare had thrown me flat the Indians thought surely they had killed me. I conjecture that from the shore they fired nearly twenty times, but none of their shots hit us, except that M. Piquet was just grazed in the head as I thought, but as he did not complain I believed it a matter of no consequence.

"To get beyond the range of the balls we all four took to the

oars, but we saw that the Indians all went aboard the flatboat we had seen near the shore and in front of which they had put some planking to prevent their being seen, and in this same planking they made holes to put their guns through so that they might fire upon us without danger of being killed themselves. I left my oar to see if our guns were in order. Of the three we had I found two loaded; one of these was mine, the other M. Raguet's carabine. I hastened to load the third as well as to prime two pistols belonging to the same M. Raguet. During this time the Indians advanced upon us, and as they did not fire, one of us, I know not which one, proposed to raise a white handkerchief in sign of peace, judging it would be better to be a prisoner among the Indians than to be killed. They got nearer and nearer to us, even with some sign of friendship, and as they were near us one of them was on the point of entering our boat, and as this unhappy man held a knife in his hand, I judged, with some reason I believe, that he had no praiseworthy intention. I seized a pistol and sent two balls into his stomach. The pistol was no sooner fired than all the Indians, who were then standing, threw themselves flat in the boat, and in this position fired upon us. Then M. Raguet took his carabine and fired in turn upon them, and I did as much. Raguet fired three or four shots, but unluckily in his haste he put the ball in before the powder, which a little retarded the quickness of the firing, and when, having reloaded his carabine, he wished to fire, not well seeing how to aim, he put his arm outside the boat, and it was at once broken by a gunshot fired by the Indians. (In a note at this point Dr. Saugrain adds: Someone at the falls of the Ohio said that I did wrong to fire; I think so too, for in the boats which have been taken before and since no one has been killed, inasmuch as no one has made resistance.) I, who put my hand outside to hold my gun better and to aim better, had a finger of my left hand broken. At the first shots that the Indians fired from their boat into ours the American who was with us jumped out and swam to land. This did us much harm, for then the Indians, who perhaps had left us, fired much more. M. Raguet had his arm broken and I my finger.

I think I fired but once afterward. As for M. Piquet, he did not wish to fire, thinking, I believe, that the Indians would do him no harm if they took him prisoner, and, instead of aiding us in our defence, he followed the example of Mr. Pierce. As there were left only M. Raguet and myself, we both threw ourselves into the water. As he had his arm broken and did not know how to swim, I believe he was drowned, preferring, as he told me, to be drowned to being scalped by the Indians. I had not yet reached the shore when I saw M. Piquet and two Indians waiting for me, and I had no sooner reached the shore than they took me and bound my hands behind my back with some girths which serve them to hold up their blankets. They had just finished tying me when I saw one of the two who held me go to M. Piquet, throw him upon the ground, and after having opened his coat and pulled open his shirt, give him four stabs with a knife on one side and one on the other, and then he scalped him. He put his scalp into a pocketbook, which M. Piquet had in his pocket. I leave you to think, my friends, what a spectacle for me! I expected for myself, as you well imagine, a like fate. But instead of killing me they made me run to overtake the boat, which, although it was headed toward the shore, had drifted nearly a quarter of a mile from the place where we swam ashore before they could come up with it. When we got opposite our boat one of the two went into the water and wished to take me by the hair to lead me, for the boat could not come near the shore on account of the trees, which prevented it. As for me, such cruel fear seized me, seeing that he had not killed me and that he wished me to cross the Ohio, I believed that he wished to burn me on the other side—in short, I made an effort violent enough to break the straps that held me bound and I threw myself into the water and swam with such force that he did not wish to run the risk of following me; and he did well, for my plan was, if they came after me, to seize one of them and drown with him.

"Those who had jumped from their boat, swimming to take us on shore, got into the one they had just taken from us and began to cross the Ohio. As for me, I held on to a tree, with my

arms about it. Those Indians who were in the boat fired at me and wounded me in the neck. When I saw the boat midway of the Ohio I regained the shore, and when I went to see if M. Piquet were quite dead, I perceived Mr. Pierce, who had concealed himself in the ravine. He came to me, and we went to see M. Piquet, who was quite dead, and in turning him over I saw that the Indians had not taken his watch. I took it and likewise a knife and two dollars he had in his pocket. Mr. Pierce cut a piece of his coat to cover his feet. I had not the same forethought, of which I repented. We left there M. Piquet, and we began to walk. It was very cold and I had nothing upon me but a shirt and a pair of large breeches. I lost my shoes while swimming. At first we went a little away from the bank of the Ohio through fear of being seen by the Indians, who were on the other side. After having made about four or five miles, night began to come on. I was very tired. I lost much blood by the wound I had in my neck, and as we found ourselves in a good place to sleep, there being much dead grass there, we lay down, and Mr. Pierce had the kindness to pull up a quantity of the dead grass and we covered ourselves with it. I slept nearly three hours and my companion awoke me. We went back to the bank of the Ohio and he began to wish to make a raft. But he never could have succeeded, seeing that he was alone, for my neck was so swollen that I could not move my right arm, and my left hand was also much swollen. Seeing that it was useless to work, for the vines of which he made use to fasten the pieces of timber all broke, we abandoned the attempt at making a raft, and began to walk, and walked a great part of the night. At last about four o'clock we lay down again. A fallen tree was the place Mr. Pierce chose. He lay down under it, and I got as near him as possible. It came on to snow, and as my feet did not come under the tree, and as it rained a little, I found my feet frozen when I awoke. I rubbed them a long time with snow, but uselessly. They caused me no pain, so we made a good day's march, always following the bank of the Ohio, in the hope that we might see some boat, which, going down to the falls, would take us in. We were obliged to cross

three or four creeks. The number of deer, of pheasants, and turkeys we saw is quite inconceivable. We also saw four or five troops of buffaloes, which came so near us that with a pistol I could have killed some. Night came on, and we lay down. It still rained a little, it is true, but that not the less caused much pain to my feet. The next day I could hardly walk, and my companion, who was impatient, left me often very far behind him. But I found a way of making him come: it was to sit down, and he after having waited for me for some time, thinking that something had happened to me, retraced his steps, and seeing my feet as black as coal and that I could not walk, he gave me his arm, and he also cut a piece of his shirt to wrap up my hand. My neck was extraordinarily swollen, but it did not bleed any more. I chewed up a sort of agaric, which I put on it. We kept on walking, but very slowly. I saw a stinking beast (bête puante), a skunk, and Mr. Pierce had no sooner seen it than he ran after it, and with a blow with a stick he killed it. After skinning it he wished to eat some of it, but he could not. As for me, I cut off some little bits and I swallowed them like pills. This did me little good, I assure you. We could have cooked it had it not been for fear that the Indians would come to us, seeing the smoke. I could have made a fire without much trouble. The sun shone, and I had two watches, the crystals of which would have made a lens by filling them with water and fitting them together. At last, after making so excellent a repast and a considerable halt, I took the rest of the stinking beast and put it in my shirt to carry it. About five o'clock in the evening we came to a house which had been abandoned. I was told (afterward) it was fifteen miles from the Big Miami, the place where we were attacked.

"When we had rested half an hour a fresh desire seized us to make a raft, and we put into the water everything we could, and while my companion did the heavy business, as carrying the doors of the house, some fence or poteaux de barrière, etc., I cut into pieces my companion's jacket, which was made of buckskin, for that is very much in use in America to make cords, and I cut the seat from my big breeches to make some socks and cover

my feet. The whole affair went on very well; the raft was made, and we were going aboard when from the other side of the river Indians fired at us. This did not alarm us much, considering the distance, but what did make us afraid, and especially me, was the Indians who replied from the side where we were to the cries of those on the other side. Then I took to my heels, and never in my life do I think I made so good use of them. My feet no longer made me suffer; in short, I felt nothing. My companion, however, was still more alert than I, and in two minutes I lost sight of him. At last I was obliged to stop, because in running a piece of stick ran into my foot. My companion in misfortune retraced his steps, and as night protected us from the Indians, we lay down, and it was one of the worse nights I have passed in my life. I could not sleep, and at each moment I thought I saw Indians, and the march the next day was still worse, for although wide awake I saw Indians behind all the trees; each bit of wood was a gun, and I believe to alarm us more, all the deer had conspired. I had great need of food—much exercise, involuntary baths, the quantity of blood lost—I ate some more stinking beast, 'polecat.' Before sunrise we were on the march; for the time I walked more on my hands than my feet. I drew myself along I know not how. We came to a creek, which I believe is a few miles from Big Bone Creek, and there for the first time Mr. Pierce and I had a little dispute. The question was about crossing a large creek. Mr. Pierce wished to go up to cross it; I was strongly for swimming across it. Seeing that he wished absolutely to make the grand détour and leave the bank of the Ohio, I did as I always did. A violent part seemed to me the best. How much he has since thanked me for it! To put an end to the dispute I went into the water. He had his back turned and could not oppose my plan. I was already in the water before he was aware of it. Thus I crossed fortunately, and he did not delay to follow me. It was about eleven o'clock in the morning. We stripped ourselves stark naked and dried our clothes. This bath did us good. When we were dressed we continued our route.

"Nothing unusual happened to us until we got to another creek, which was nearly four miles from the last one we just crossed. As we were about to swim across it as we did the other, Mr. Pierce saw two boats coming down the Ohio. He called to them, but the boats kept off, believing we were Indians, but seeing our white shirts and our breeches they determined to come to us. For this purpose they put all the men into one of the boats and left the other with the women and just one man to steer it. This took quite a long time, during which the current kept carrying them on. This time I did not have to beg Mr. Pierce to cross this creek, as well as two or three others which followed it. As for me, I followed him, but much more slowly. At last we swam out to join them, for they could not approach the shore on account of the trees, which prevented them. It was surprising to me, arrived on board, to see all the people of the boat that received us with carabines in hand. But the fear of being surprised by the Indians obliged them to be on their guard. Arrived on board they undressed me, warmed some whiskey, and rubbed all my body, which did me much good. I drank a little of it and ate a little bread, which seemed to me good. They dressed my neck, which was much swollen. As for my hand, they did nothing for it. They waited until we should be at the falls to cut off the finger—which was not done, thanks to myself. My feet were in a very bad condition and gave me much pain.

"Two days' sailing was enough to bring us to the falls, where I passed the night of March 29th. The next day, which was Sunday, I crossed the Ohio to go to a fort situate opposite Louisville, where I was most cordially received. I was introduced by Colonel Blaine (here a footnote), whose acquaintance I made at Fort Pitt. He had come down some time before us and arrived at the falls without accident, and Major Willis gave me a reception for which I cannot be too grateful. In short, I stayed in the fort with all possible comfort from March 30th to May 11th. For three weeks I could not move, and every day they had to take out some portion of my foot, which began to putrefy; but with the care of the fort's surgeon and with patience all has been well, and my

foot is quite cured except the place where the piece of stick went in when I was running away in the woods. Thus far I have been unable to cure it.

"Loüisville is quite small. Nothing wonderful is found in it. The ruins of an old fort (Fort Nelson) are to be seen; they are upon the bank of the Ohio, as is the town. I believe they do not at all exaggerate its unhealthiness. The city and its environs are very sickly. There are found, even in the town, low grounds filled with water, from which exhales the most dreadful stench, especially in the heat of summer. It would not, however, cost much labor to drain these marshes which give the inhabitants fevers, which, if not mortal, are long in curing. The other side of the Ohio where I stayed some time, where an American fort (Fort Steuben) is built, and where there are two hundred men in garrison, is not more healthy than Louisville, and there are few persons free from fever. This fort is in a very pretty situation. The land there is excellent, and there are trees on every side."

In his record he states that he had left Pittsburg March 18th and was attacked by Indians the 23d, was three days in the woods, and two days in the boat which picked them up. He made himself at once useful at the fort, examined some mines on Silver Creek, and analyzed a specimen which was brought to him which was supposed to contain gold, but which proved to be iron pyrites and copper. There was a lead mine fifteen miles from the post which yielded abundantly, but mixed with bismuth.

While at the fort Saugrain made a furnace and furnished the doctors fixed alkalies, and amused them with electric experiments; salt, he states, was made in abundance in the neighborhood, and sold at $2 a bushel. From some stones which he picked up and which were encrusted with shells, he came to the conclusion that this part of the country had once been covered by the sea or a great lake. In this he anticipated the later demonstration of the glacial markings. Flint stones good for arrowheads and gunflints were everywhere found. Quintucké (Kentucky), he remarks, was everywhere covered with a cane which

makes a good food for cattle. Turtles, geese, turkeys, ducks, plover, and quail were found immediately about the fort, but the deer had been frightened by drum and fife to a distance of several miles. It was here that he brought home some chalybeate water, and, by adding it to an infusion of oak bark, made ink with which he was then writing, and which he thinks will not fade. He also found a resin, which he calls copal, from a tree called the sweet gum. This discovery had not been made before, so in his honor they planted a specimen in the fort and called it Saugrain's tree.

From April 21st to May 3d he counted thirty-four boats passing down the river. May 7th a boat with fourteen rowers and eight or nine passengers arrived from Vincennes. They had been attacked one hundred and fifty miles below and two of the party killed. This boat was going on to Pittsburg, and the doctor expected to go with them, but decided finally to accompany Colonel Blaine on horseback through Kentucky so as to see the country, and then meet the boat at Limestone May 11th. He set out alone with Colonel Blaine, after expressing great regret at leaving the fort, where he had received so much kindness. He comments on the fertility of the soil, the small size of the trees, the bad roads, and the fact that the plantations were mostly in barley. Their first stop was Bardstown, which had several stone houses, and a handsome court-house, which led him to believe that the people indulged in law suits.

Danville he found a charming settlement, with land the best in the world. Here they were joined by two Philadelphia ladies, both pretty, and Colonel Blaine's son. A party of fifty armed men passed through Danville and two fugitives arrived of a party of seven from Richmond who had been attacked by Indians, one killed and the rest scattered. From here they went to Lexington, crossing the Kentucky River where the banks were high and rocky. Lexington he found pleasant, with good water and less idleness than elsewhere. A pest of caterpillars had stripped the maple trees, which supplied the people with sugar, and would prove a severe loss. After two days they set out for Limestone,

stopping at Bourbon. Even at that early day visitors to Kentucky felt something was wanting unless they became familiar with Bourbon—a practice which prevails to the present day.

They dined at Saline Bleu (Blue Lick). Here you see the extraordinary spectacle of two springs, one salt and the other fresh, within ten feet of one another. Here salt is made by evaporation; it requires 1000 gallons to make a bushel. Reaching Limestone they found the boats already there.

May 21st they set out for Muskingum with a party of sixty-eight armed men and forty nine unarmed in boats laden with goods from the Indians. They pased the Big Kanawha, which is beautifully situated but very dangerous from the Indians—two white men and four Indians had recently been killed. On May 30th they reached Muskingum, which he considers occupies the finest situation for a city he has ever seen, and ventures the prediction that it may become the largest city in America. The plan of the engineers he considers admirable. June 9th they left for Fort Pitt, where they arrived June 17th, and soon left for Philadelphia with Mr. Pierce and Mr. Brason, the Postmaster of Philadelphia, who had come out to establish a branch postoffice. The latter had been directed by Dr. Franklin to supply Saugrain with money if he met him. They travelled on horseback and stopped overnight with one James Miers, then went on to Greensburg, where he was invited, he says, out of curiosity, to many houses, for the people are not hospitable. The next day, though his foot was painful and required lancing, he travelled forty miles and the next day the same distance over the Allegheny Mountains, and passed the night in a tavern in a deep valley between two high and barren mountains. "He would die of grief living in such a place, where the sun shines for two hours only."

June 10th stopped at Chambersburg, which has many stone and brick houses. A nearby creek turns fifteen or twenty revolving mills. The industries are remarkable. Gunpowder is made in quantities and sells for fifty cents a pound. They travelled over good roads and reached Carlisle, where the United States has magazines for the manufacture of arms. This town is famous

for the dissension over the new Constitution. On the way they met large wagons which carry people to Fort Pitt, from whence they take boat for Muskingum. On the way to Lancaster they crossed the Susquehanna, where it is half a mile wide and four fathoms deep. Here there is a fine court-house and several churches, and it is noted for the fine rifles they make. The population is mostly German.

On the 20th they reached Philadelphia and found Dr. Franklin sick, but well enough to extend an invitation to dinner, which was gladly accepted, though he, Dr. Saugrain, was quite ill, and not very presentable in the clothes he had been travelling in. The journey from Fort Pitt to Philadelphia on horseback was made in seven days, while the trip out in a cabriolet had required fourteen days. It is not known when Dr. Saugrain left Philadelphia, but we next hear of him again in Paris in 1790, when he became engaged in the service of the Scioto Company to join a party of French settlers from Lyons and Paris, who were bound for the Ohio, and who founded Gallipolis.

This settlement furnishes one of the most picturesque and pathetic stories of the early West. The party, some five hundred in number, was composed largely of high-classed French artisans who were illy fitted to cope with the hardships of the wilderness. There were "carvers and gilders to his majesty, coach and peruke makers, friseurs and other artists, and only four or five farmers. The brothers Caudevert were sculptors and carvers, who had already attained reputation enough to have decorated two of the most beautiful churches in Paris."

The French imagination, still under the spell of Rousseau and the *Figaro*, was fairly fired by the accounts put forth by the promoters of the Scioto Company of the "free and happy life to be led on the banks of the beautiful Scioto, untrammelled by the artificial bonds of European society." The prospectus of the company, with a map, described the attractions in glowing terms: "A climate wholesome and delightful, frost, even in winter, almost entirely unknown; a river called, by way of eminence, the beautiful and abounding in fish of vast size. Noble forests,

consisting of trees that spontaneously produced sugar (sugar maple), and a plant that yields ready-made candles (myrica cerifera); venison in plenty, the pursuit of which is uninterrupted by wolves, foxes, lions, or tigers. No taxes to pay, no military service to be rendered." Saugrain was sought because of his knowledge of the country. He was to serve three years, to have two hundred acres and a house and support for himself and three servants. For this he was to give his medical service.

The party reached Alexandria May 1, 1790, and arrived at Gallipolis October 20th, 1790; eighty cabins, a "council- and ball-room" had been erected by Rufus Putnam. At first everything "was new, the colonists had means of support, and time passed agreeably between labor and pleasure. Woods were cleared, gardens planted, and everyone strove to make himself agreeable and useful. After a day of severe labor, dancing and singing or a social and cheerful meal succeeded." (Mrs. Mentelle, Cincinnati *Evening Chronicle*, July 14, 1827.) July 14th they celebrated the fall of the Bastille with a banquet. "They had brought with them costly dresses and expensive clothing, and rare and valuable laces, articles only suitable for a gay Parisian life." One of the descendants when quite an old woman remembered seeing, when a girl, a barrel of silk stockings which was opened in St. Louis, where they had gone after the failure of Gallipolis, and which were much damaged by being badly packed. The days of prosperity were not of long continuance; the company supplies stopped; there was great want, and their title to the land was found defective. Congress finally gave them 24,000 acres. "Now the ruffled shirt and the lace of the colonist were seen adorning the American hunter and mixing with the greasy hunting shirt and leggins, over which hung in laughable discordance the embroidered coat of the Frenchman, while beautiful rings shed lustre upon the blackened hands. Nutmegs and spices were exchanged for eggs." Dr. Brackenbridge in his *Recollections of the West* gives a vivid picture of Dr. Saugrain in these surroundings. He seems to have kept an inn, and in a little back room surrounded by his "blow-pipes and crucibles" and chemical apparatus and

electric batteries he made barometers and thermometers and phosphorus matches, for all of which he found a ready sale. This work was regarded by many as uncanny and closely allied to the black art. On one of the other cabins tradition tells of the sign "Bakery & Midwifery." Saugrain had established a reputation of inoculating for smallpox, and crowds from the Kanawha Valley sought his service. On one occasion some Indians came to see him at work. The doctor placed a gold piece on a metallic plate and told the chief that he might have it if he could pick it up. He received a severe electric shock and ran howling away. The doctor, to their astonishment, then picked it up and put it in his pocket. The great fertility of the soil, he tells us, "brought emigrants without stop, full of energy to build their first cabin. They then played in the bosom of idleness. An inhabitant of the country which is in the middle of the forest scarcely works two hours a day for his living and that of his family. He spends nearly his whole time in reposing, in hunting, and in drinking. The women weave linen and make clothes for their husbands, and he has seen good linen and woollen cloth made in the cabins. There is no silver; whiskey is bought with wheat, and pork with mutton." The doctor married in Gallipolis, but soon left for Lexington, invited by a company that needed his knowledge in the manufacture of good bar iron, in which they had not been successful. He soon became popular. There is a tradition that while in Lexington he made for Henry Clay his first kite. He remained for six years, when in response to an invitation of Trudeau, French Governor of St. Louis, he moved there in 1800. The trip was made in a flatboat down the Ohio, and it took many days to work his way up the Mississippi. In 1806 he was appointed by Jefferson surgeon in the army and was stationed at Fort Bellefontaine on the Missouri. In the *Missouri Gazette*, May 26, 1809, we find the following notice: "Dr. Saugrain gives notice of the first vaccine matter brought to St. Louis. Indigent persons vaccinated gratuitously." He continued to practice in St. Louis until his death in 1820, and must have been eminently successful, for he left a large landed estate

for the support of his wife and six children. Although thus busily occupied, he found time for his electric and chemical work, and in the latter he is said to have anticipated the European inventors in the use of phosphorus for friction matches. His scientific work lives in tradition, and has gained for him the title of the "First Scientist of the Mississippi Valley." (Byars.)

His earnestness and modesty are well illustrated by a remark which has come down to us, made one day to his daughter, who was his assistant in the laboratory: "We are working in the dark, my child. I only know enough to know that I know nothing." Can we to-day say more or less?

And now, in taking leave of our little French doctor, I may say that I felt we might turn with some interest and profit from the great special questions which now press upon us for solution to the early times when the scientific knowledge of the physician enabled him to minister to the larger and more varied needs of those about him: from the "hurly-burly" of the great city to the noises and odors of the forest, from the blaze of electric lights to the beginning of friction matches, and find some interest and profit in the career of a pioneer doctor who brought with him into the wilderness the best culture of his time and applied in his daily round the best that science could then afford for the benefit of those he was called upon to serve.

Tradition still keeps warm his memory among his descendants in the great city in which we meet, and I trust that the American Surgical Association may be the means of introducing him to his proper and larger place in the profession which we represent, as one of the great pioneer doctors who has stimulated development, and place him in the position which fairly belongs to him by reason of his great attainments.

WHAT ARE THE MINIMUM REQUIREMENTS FOR ASEPTIC SURGICAL OPERATIONS?

By GEORGE H. MONKS, M.D.,
BOSTON, MASS.

When we realize to what extent a large general hospital is a sort of dumping-ground, as it were, for all kinds of septic material, and that in many of these institutions there is, every few months, some change in the personnel of assistants or nurses, and especially if the situation is still further complicated by a large staff of surgeons whose services are interrupted, it must at once be evident, from the point of view of asepsis, under what disadvantages the surgeons of these hospitals do their work. Because of these manifest disadvantages the task of attempting to simplify the various aseptic processes in use in such hospitals is a delicate one. And yet the number of aseptic precautions has now increased to such a degree as to make it desirable, for the sake of simplicity, and in spite of the good results usually obtained under the old methods, to determine, so far as is possible, which are the really essential parts of the process and which can be done away with. It is obviously impossible, in such a subject as asepsis, to state dogmatically the exact degree to which the various details may be cut down without danger. I shall, therefore, content myself with making a few general observations on the subject, endeavoring at the same time to make no positive statements unless I feel that the known facts justify them. In doing this I shall pass over certain details as being too trite for discussion, and limit myself principally to points which to some may appear not so obvious, or about which there may be difference of opinion. Most of the methods here advocated have been put into practice at the

Boston City Hospital. It is not claimed that all these methods are better than any others, but simply that they represent one of the ways, consistent with simplicity, in which satisfactory results may be secured.

(A) PREPARATION FOR AN ASEPTIC OPERATION.

STERILIZATION OF MATERIALS IN THE STEAM AUTOCLAVE. It is found that exposure of materials[1] in the autoclave to a pressure of fifteen pounds of saturated steam for one-half hour is all that is necessary, provided that the bundles are loosely done up and loosely packed, so that all parts of them are readily accessible to the steam. This is, of course, a great saving in time over former methods, at least as I have seen them practised. The half-hour should start from the time the air has been completely driven out and the pressure gauge registers fifteen pounds. The suggestion for diminishing the amount of time in using the autoclave was made to me by Dr. Charles Harrington. That one-half hour is quite sufficient in practice has been proved by the pathological department of the hospital; in fact, bundles containing cultures of the hay bacillus in its sporing stage have been found sterile even after fifteen minutes in the autoclave at fifteen pounds' pressure.

Salt solution is sterilized in flasks by exposure for one-half hour at ten pounds pressure.

PREPARATION OF ABSORBABLE LIGATURES. At the Boston City Hospital sterile catgut and kangaroo tendon are furnished to the hospital by reliable dealers. It is thought that, as practically the entire business reputation of such dealers rests upon the sterility of their catgut, it is more likely to be sterile than when prepared in the hospital. Where the hospital facilities justify it, however, undoubtedly the best method would be to have it prepared in the institution itself under the eye of the surgeon.

OPERATING-ROOM. Whatever may be the actual danger of air infection, direct or indirect, and pending the results of more definite

[1] Gauze dressings, sponges, strips, pads, gowns, caps, sheets and towels, silk sutures and ligatures, silkworm-gut, silver wire, etc. Where space is wanting, the gauze dressings may be baked.

experiments, the demonstrated existence of pathogenic bacteria in the air of large hospitals[1] is presumptive evidence of the necessity of *some efforts* looking toward their exclusion. Because of the general truth that the more dust in the air the more bacteria, our efforts should, naturally, be in the direction of diminishing the amount of dust which is in the room, and of keeping such as remains quiet, thus leaving the air as free from it as possible. Therefore, as belonging to "minimum requirements," it is necessary to mop the floor, wipe the walls, fixtures, and furniture with damp cloths, and to minimize draughts from all sources. That the room should be such as to be easily cleaned is self-evident.

Chandeliers above the operating-table, on account of their catching the dust, and because of the difficulty in cleaning them, should be as simple as possible.

It will be extremely interesting to note whether sweeping by the vacuum system, now so extensively used in office buildings, may not be of value in thoroughly removing the dust from operating-rooms. By this method the loose dust is sucked up from the different parts of the room, through a nozzle at the end of a hose,

[1] In order to determine whether the air in the surgical amphitheatre of the Boston City Hospital contained essentially the same number and variety of bacteria found in other hospitals, the Pathological Department, at my request, made exposures of Petri plates for different periods of time during the twenty-four hours. Their conclusions were:

"1. That at no time in the twenty-four hours is the air free from organisms.

"2. That more bacteria were found after the air had been stirred up, as after the morning cleaning and the class exercises. The smallest number were found between the hours of midnight and 7 A.M.

"3. The vast majority of the organisms found were harmless saprophytes, though in some plates of every series staphylococcus albus and aureus were found. The streptococcus was found in two instances only.

"4. There was no great difference in the number of colonies obtained at different levels, excepting on those plates laid upon the floor, where the number of colonies was much in excess over the other plates. This was due to the people who passed through the amphitheatre at all hours."

These results are essentially the same as those of other investigators, all of them going to show that while air infection may not seem to be enough of a danger to require more than ordinary precautions, yet the possibility of infection in this way should not be disregarded, especially in a large hospital.

and is carried to the basement. I am not aware, however, that as yet the system has been installed in any hospital.

The proper disposal of septic material is *essential*. The usual method of throwing it into a hopper is probably safe, though a description of the trap-door method, which I understand is now in use in Hamburg, sounds more attractive.

Thorough and systematic fumigation of the operating-room with formalin gas is, in my judgment, essential, at least after all septic cases.

It is possibly safer to have one room for septic cases and another for clean ones, although it is not at all certain that, with careful cleansing and proper fumigation, one room is not sufficient to meet the "minimum requirements."

The advantage of the common practice of allowing the operations on clean cases to precede those on septic ones is so obvious as to hardly need mention.

An operating-room, then, which can be easily cleaned, and *which is cleaned*, where the air is kept comparatively free from dust, where draughts are minimized, and where formalin fumigation is regularly and thoroughly practised, must, for the present at least, be regarded as all that is necessary to meet the "minimum requirements."

All elaborate or ornate fittings or furnishings giving the *appearance* of cleanliness are luxuries of questionable value, if, indeed, they are not positive dangers, as they tend to give a false sense of security.

Preparation of the Patient's Skin. Experience seems to have demonstrated that in the preparation of the patient's skin no special aseptic precautions are necessary on the day before operation. The patient should be given a hot bath, and the operating area should be thoroughly cleansed with soap and water and then shaved. That further preparation of the skin is presumably unnecessary is shown by the fact—probably corroborated by the experience of most surgeons—that accident and other emergency cases, on which only the final preparation is made, seem to do just as well, aseptically speaking, as those

cases prepared with great pains in the hospital the day before. This suggestion—as to the source of which I am ignorant—has greatly simplified the aseptic process.

Chemical depilatories have been recommended by some, as being quite as efficient as the razor for removing hair, and as having also an antiseptic effect of their own. I have had no actual experience with these agents, except to witness their extraordinary action in removing the hair from the arm and leg. Because of the fact that chemical depilatories, even if they should prove to be unirritating to the skin, are unstable compounds, and are practically useless if not fresh, their use in general surgery would appear to have no special advantage over the razor.

Though a perfect sterilization of the skin of the patient—and this applies equally to the hands of the operator and his assistants—is probably impossible under any method, the use of 70 per cent. alcohol[1] has given very satisfactory results as a routine procedure for the last few months at the Boston City Hospital. After a thorough mechanical cleansing of the operating area the alcohol (70 per cent.) is allowed to drip upon it for two minutes, the part being gently scrubbed at the same time with a sterile wad of gauze in the sterile hands of an assistant.

Disinfection of the Hands.[2] The use of 70 per cent. alcohol has been found equally satisfactory for disinfecting the hands;

[1] This was recommended to me by Dr. Harrington, who proved its value by bacteriological experiments. He declared that while absolute alcohol has no effect whatever on dried bacteria, alcohol of 70 per cent. is a very satisfactory germicide. It is not claimed that this method is better than any other, but only that it yields equally good results, while it is simple, comparatively unirritating to most skins, and, for hospitals, at least, inexpensive. The admixtures required by the United States Government do not detract from its efficiency.

Sometime ago Dr. Harrington furnished me with a new mixture—"No. 9," he calls it—which, judging from the bacteriological tests made at the hospital, is strikingly effective in disinfecting the hands. As yet I have had no satisfactory opportunity of testing it clinically; but I am convinced from these experiments that, should it not prove too irritating, it will be of great value, especially in disinfecting the skin of the patient, and may displace even alcohol.

[2] It is hardly necessary to call attention to the well-known necessity of avoiding contamination of the hands at any time with septic material. Sterile instruments should be used in changing septic dressings, or rubber gloves should be worn.

this, of course, after a very thorough mechanical cleansing. The details are as follows:

1. The hands are very thoroughly washed in hot water, a bristle brush being used. No time is specified for this process, it being required only that the hands should be thoroughly clean in the ordinary sense, and the skin soft. Obviously, such a process should take longer with some hands than with others.[1]

2. The hands are thoroughly dried with an ordinary clean towel. During this process a good deal of softened epidermis may be rubbed off. The nails, being now comparatively soft and pliable, may be trimmed with the scissors, and the closer they are trimmed the better. The spaces beneath the extremities of the nails are now cleansed by the nail-cleaner, the projecting flesh at the base of the nails is pushed back, and all hang-nails cut off.

3. The hands are washed a second time with soap and hot water.

4. They are washed off with sterile salt solution.

5. They are soaked in 70 per cent. alcohol *for two minutes.* This is the only part of the process where time is specified.

6. The hands are dried on a sterile towel, and they are ready for the gloves.

Gloves.[2] I am aware that some successful surgeons do not use gloves, nevertheless I am unable to accept this as evidence of absence of danger from the ungloved hand, for what may not be a danger with one man may be so with another. Rubber gloves should be thoroughly washed after operation and boiled for six minutes. They should then be inspected for punctures. If it is possible to repair them, they should be mended, and then tested again. They should then be powdered, wrapped in cloths, and

[1] The suggestion of Freeman that the hands be given a chance to perspire by wearing gloves for a long time before sterilization or by immersing the gloved hands in hot water, seems an excellent one, but it adds very much to the detail of preparation.

[2] The only method of procedure which, *if ultimately it prove practicable,* is likely to replace the use of gloves, with the attendant danger of infection from puncture, is covering the hands with an impermeable coating.

sterilized in the autoclave for one-half hour at ten pounds' pressure.[1]

Instruments. The customary ten minutes' boiling of instruments has been proved to be sufficient, if properly carried out. One source of infection is the neglect of a precaution, well-recognized, but, to my knowledge, not always carried out. It is absolutely essential that instruments which are difficult to clean, and which remain for a long time in close contact with the tissues in a wound, should be taken apart before sterilizing. Hæmostatic forceps, for instance, with their corrugated jaws, are particularly dangerous, if not unlocked before being boiled. Cultures taken from the jaws of forceps which had been soiled with pus, the jaws tightly locked, and the instruments boiled for ten minutes, still yielded positive results. When one considers how hæmostatic forceps crush the tissues, and how long they stay in contact with them, it is difficult to imagine a better method of infection in case the jaws are not sterile. No excuse should justify failure on the part of the assistant to satisfy himself that the forceps have been properly sterilized.

Caps and Masks. The theoretical danger of infection from the head and mouth of the surgeon justifies our insisting upon the wearing of caps and masks at aseptic operations—at least at major operations—until their necessity is disproved. If caps are not worn the surgeon's hair often comes in contact with that of his assistant, directly over the wound, and particles of dust, dandruff, and bacteria are likely to descend into it. I have good authority for the statement that saliva contains more bacteria, volume for volume, than sewage.[2] Minute particles of highly

[1] Wandel and Höhne seem to have succeeded in sterilizing rubber gloves by mechanical cleansing alone, but I do not know that their methods have been put into general practice by others. Sterilization by simple boiling is exclusively used by some surgeons.

[2] "In addition to the care of the hands, the surgeon should also have washed his face thoroughly, and if he wears a beard or mustache, special heed must be paid to the cleanliness of these. Very little attention is usually paid to the cleansing of the mouth; yet when it is remembered that the saliva contains a larger number of micro-organisms than the worst sewage, that streptococci and staphylococci are

infectious material may be expelled from the mouth, and possibly from the nose during talking, coughing, or sneezing.

The gauze mufflers which are generally used for masks are most uncomfortable to wear during an operation, and, if the surgeon wears glasses, these are apt to be obscured from time to time by his breath, which escapes from the muffler just below them. I have found the Vienna masks, made on a wire frame, much more comfortable than the ordinary mufflers.

Solutions. The tendency nowadays is to dispense with all solutions during an operation, except warm sterilized salt solution for irrigating and washing. Dipping instruments into corrosive solutions, or rinsing the hands for a few seconds, as we see so frequently done, has no antiseptic effect whatever.

(b) conduct of aseptic operations.

In the conduct of an aseptic operation the following are essential on the part of all engaged:

1. Belief in the aseptic idea.
2. Fixed habits of asepsis.
3. Co-operation or "aseptic team work."

Assistants should be taught, what the surgeon already knows, that the fewer the hands entering into an operation, the less the wound is touched with the fingers, the less the talking over it, the shorter the time consumed in operating, and the less the ligatures are exposed or handled just so much less is the danger of infection.

The care of the ligatures, as we all know, is one of the most important details of the operation. Unlike instruments, and, therefore, more dangerous, they are put into the wound to stay there, and if bacteria go with them such bacteria are not so likely

among the most numerous of these, and that they are proved to pass into the air in loud talking or coughing, it would appear worth the surgeon's while to take into account a cavity which comes so near the operation wound." Lessons in Disinfection and Sterilization; F. W. Andrewes, Lecturer on Pathology, Pathologist and Sanitary Officer to St. Bartholomew's Hospital, London, 1903, p. 123.

to be removed later, during sponging or irrigating, as those introduced in other ways. It is rather unfortunate that the usual way of putting up catgut is to roll it upon a glass reel, for the temptation to straighten it out in the fingers is almost irresistible; in fact, this, to some extent, is necessary, but the process may easily infect it, especially if it has to pass from hand to hand.

Considering the fact that probably few wounds are absolutely germ-free, and also that latent germs in the tissues may be awakened by injury, *assistants should also be taught* the importance of injuring the tissues as little as possible by manipulation or too much irrigation; of the necessity of removing blood and stopping hemorrhage; of leaving a dry wound; of uniting the deeper parts of it by buried stitches, enough room being allowed between them for drainage, and of remembering to apply this same rule to skin sutures, special drainage being used for large wounds, particularly where "dead spaces" exist.

In addition to learning the necessary measures to be taken before and after the operation to diminish the chances of autointoxication, *assistants should also know* the importance of strengthening the resisting power of the patient's tissues in every possible way, for the general physical condition of the patient, and possibly the psychical, may often, so far as asepsis goes, be the determining factors in the case.

All these, and many similar points, should be inherited, as it were, by one assistant from another, and become incorporated into that common knowledge which, especially in a hospital where change is the order of the day, is of more value in keeping up the standard than all else, namely, "hospital tradition."

Many of these precepts the nurses should be equally familiar with, and it belongs to those in charge of the training school to instruct them in the theory of asepsis, and to the surgeon or his assistants, but especially to the head nurse in charge of the operating floor—a person who is usually selected for her general efficiency in surgical work—to see that they are made familiar with the proper practice of it.

SUMMARY OF MINIMUM REQUIREMENTS FOR ASEPTIC WORK AS GIVEN IN THIS PAPER.

1. Materials to be sterilized in saturated steam in the autoclave for one-half hour under fifteen pounds' pressure; rubber gloves and salt solution under ten pounds' pressure.

2. In hospitals without proper facilities for sterilization of absorbable ligatures, these to be obtained from reliable dealers whose business reputation is at stake.

3. An operating-room, such as to be easily cleaned, and *which is cleaned*, where the air is kept as free from dust as possible, where draughts are minimized, and where formalin fumigation is thoroughly and systematically practised.

4. A hot bath for the patient, and a cleansing and shaving of operating area the night before operation if possible (as an extra precaution). Just before operation a second cleansing and sterilization with 70 per cent. alcohol or by some equally efficient method.

5. Thorough mechanical cleansing of the hands, and sterilization by 70 per cent. alcohol or some method equally efficient.

6. Ten minutes' boiling for instruments, special attention being paid to taking apart of clamps and hæmostatic forceps, or at least unlocking them.

7. Caps, masks, and sterile gloves always to be worn, at least in major cases.

8. Warm sterile salt solution for irrigation and washing.

9. Belief in the aseptic idea, fixed aseptic habits, and aseptic co-operation on the part of all engaged in an operation.

10. Instruction of assistants and nurses as above set forth.

MINIMUM REQUIREMENTS FOR ASEPTIC SURGICAL OPERATING IN A HOSPITAL IN WHICH THE PERSONNEL OF THE OPERATING-ROOM IS PERMANENT.

By A. J. OCHSNER, M.D.,
CHICAGO, ILL.

Methods can best be tested under the conditions indicated by the subject of this paper, because they imply that the responsibility rests upon one person at the head of the surgical work, and that he is permanently supported in his efforts by a staff of assistants who are directly responsible to him, and are consequently bound to apply the principles laid down as valid by their chief.

This makes it possible to develop certain definite methods which are applied constantly by responsible persons in a large series of consecutive cases, and if the methods should not be followed by satisfactory results it is possible to locate the cause of the failure and to change the methods accordingly until they are satisfactory, and to eliminate such members of the personnel as may be found incompetent to carry out the methods contemplated by the plan.

In order to secure the best possible results such a system must be: 1, simple and yet comprehensive; 2, it must be uniform; and 3, above all things, it must be reasonable.

Simplicity. Any system which is complicated is certain to contain elements which will not be fully comprehended by some persons who may be necessary to carry out some portion of the plan, and if any one point is omitted in a system the result of the entire system cannot be satisfactory. Moreover, it is correspondingly more difficult to locate the cause of trouble in any given case.

It is true that many most complicated systems have furnished large series of successful results, but the results have in no way

excelled those obtained by vastly simpler methods. Of course, so long as the useless complications in any given system are at the same time harmless, the results will be as satisfactory with as without them.

Uniformity. One of the most important elements in the development of a satisfactory system lies in the uniformity with which it is practised by the chief. If the chief does not uniformly do the same thing in the same manner under the same conditions it is impossible for his assistants to thoroughly acquire a system. Of course, it is wise to make changes in order to perfect every system, but this should be done only after careful consideration and not in a haphazard manner. In this manner the youngest assistant without responsibility can acquire the principles involved in the system, and as he continues in his service he will be able to carry out his part without doing mischief, because he has seen each step done many times before he is called upon for responsible action in the same direction.

Reasonableness. Surgery is more and more coming to be a very reasonable, logical profession, and in developing a system of aseptic practice one can count with much greater certainty upon the probability that everyone concerned will carry out the details if he is expected to do things which would appeal to a sensible person than if he is expected to go through an unreasonable routine performance.

The system must provide for every contingency, and each element of the system must be carefully studied before it is established. Conditions differ vastly in different institutions, and it is consequently necessary to adjust each individual system, so that it provides for all the conditions involved in any given institution.

There must be a definite responsibility, which can be established best by having the chief take the blame for all failures. If the system is carefully planned and the chief is judicious in the selection of his assistants, failures are to be looked for very rarely; and when they do occur the indication is usually, barring accidents, of course, that there is some element of the system which requires further perfection.

I will briefly outline the system in use at the Augustana Hospital, because we have practically all the conditions implied by the title of this paper and because the system has been developed by constant effort during a period of fifteen years under the same conditions. The methods have been accumulated by visiting many hospitals in this country and abroad and by weighing the current literature during the entire period since the introduction of antiseptic surgery. The chief effort has been to simplify the methods, at the same time striving to secure the best results.

Disinfection of the Patient. Unless there is some special reason in the physical condition of the patient, the following steps are taken in his disinfection previous to performing any operation: He receives a full warm soap and water tub-bath on the day before the operation. For the disinfection of his alimentary canal he receives two ounces of castor oil in the foam of beer directly before taking his bath, and a large warm-water enema on the morning of the operation, except in case of operations upon the rectum. In these cases the enema is given on the evening before the operation.

On the evening before the operation the skin over the seat of operation is thoroughly scrubbed with green soap and warm water, then shaved, then scrubbed with strong alcohol, then a moist dressing of gauze saturated with a 3 per cent. carbolic acid solution is placed over the field of operation; over this a large covering of absorbent cotton held in place with a gauze bandage completes the dressing. Just before the operation this dressing is removed and the surface again scrubbed with strong alcohol. For several years we always prepared the skin over the region of the operation immediately before beginning to operate, and found it perfectly satisfactory, but it consumed too much of our time, consequently, we now have this done by the surgical nurse on the previous day.

Disinfection of the Operator and Assistants. The most important precaution taken is to keep the hands out of pus. In dressing suppurating wounds forceps and rubber gloves are used, so as to prevent the hands from touching pus. The operations are performed early in the morning before anyone connected with the wounds has made dressings. The fact that it is bad practice

to soil one's hands with pus is impressed most forcibly upon everyone connected with our work.

Aseptic cases are always operated first, and later those containing pus. In operations upon suppurating cases, rubber gloves are used at the present time, but in former years, by taking the precautions indicated above, practically no infections took place, although no gloves were used.

I operate upon alternate days, so that on the intervening days the same precautions can be taken in dressing the wounds—no suppurating wounds being dressed until all clean wounds have been finished.

Every evening before retiring the surgeon and all the assistants scrub their hands with the same care that is employed in disinfection before an operation. The assistant who has charge of the patients who are primarily aseptic has nothing to do with the patients who are not aseptic primarily from the character of their disease, and *vice versa*.

The aseptic assistant prepares a table of all the cases which come under his care during this portion of his service, upon which he notes the names of the patients, the age, diagnosis, duration of disease, operation, number and dates of dressings, the result as regards the wound, the date of admission, and the date of discharge. This record is filled out every evening and acts as a remarkable stimulant to careful and conscientious work, and the practical results are exceedingly satisfactory. I will add one of these monthly tables for the purpose of illustration.

I speak of these conditions first because they go to form an aseptic conscience in those connected with surgical work, and upon this depends the condition of the wounds rather than upon any special method.

At the present time we wash our hands in an ordinary deep porcelain basinful of warm water, using green soap, with a moderately stiff brush; then we carefully cleanse the finger-nails with the point of a dull scalpel; then we scrub them once more with a brush, and then with a piece of sterilized gauze in the deep basin, because the gauze seems to rub off all the loose epithelium more

perfectly than a brush; then we wash off the soap under the faucet in a stream of warm, boiled water; then we wash in 1: 2000 corrosive sublimate solution for a few moments, and then with strong commercial alcohol. I have varied this plan from time to time experimentally, and have found that after washing carefully with soap and warm water and cleaning the nails and washing once more thoroughly, our wounds remained aseptic. The same was true if we supplemented this by washing with a sublimate solution, with or without alcohol, or by washing with the alcohol without the sublimate solution. There is one point, however, that I insist upon, viz., that everyone connected with the operation have a smooth, unbroken skin upon his hands or wear rubber gloves. Both of the assistants and the surgical nurse wear rubber gloves during all operations, while I wear gloves only in operations in the presence of pus.

We are careful not to breathe or speak into the wound. Everyone connected with the operation is constantly on guard to prevent accidental infection of anything which may touch the wound. One nurse alone touches anything coming in contact with the wound, her assistant does anything else that may be necessary.

Disinfection of Instruments. All instruments, except knives, are boiled for half an hour in a solution of a tablespoonful of baking soda to the quart of water before they are put away after operations, and again before they are used. The knives are washed carefully with water and then rubbed with pads of sterilized cotton, saturated with alcohol, before and after using.

Disinfection of Silk, Silkworm-gut, Horsehair, Drainage-tubes, and Brushes. This is accomplished by boiling in water for one hour and preservation in 5 per cent. carbolic acid in water, or in strong commercial alcohol, until used.

Catgut is prepared by immersing in sulphuric ether for one month; then for one month in strong commercial alcohol, in which one grain of corrosive sublimate to the ounce has been dissolved, the solution being renewed once during this time. It is then preserved indefinitely in a solution of one part of sterilized iodoform, five parts of ether and fourteen parts strong commercial alcohol.

It is never handled by anyone except my chief assistant and myself. It is never placed in water. This catgut will last seven to ten days in tissues, according to the size used. It is used for all ligatures, both in the peritoneal cavity and elsewhere, and for all buried sutures except in herniæ and in the suturing of bones. For these purposes we employ a chromicized catgut, lasting from twenty to thirty days, according to size. This is prepared after the following formula: The catgut is immersed in ether for one month, then in a solution prepared as follows: Dissolve one ounce of chromic acid in five ounces of water and add to this one quart of pure glycerin. Immerse the catgut in this solution for seventy-two hours, then wind on wooden boards or ground-edged slides, such as are used for mounting specimens for microscopic examination, and place in a solution of one part carbolic acid in five parts of glycerin for two weeks; then preserve indefinitely in the iodoform-ether-alcohol solution described above. It is important to dissolve the chromic acid in water before adding the glycerin in order to prevent an explosion. The catgut prepared by these methods is strong, pliable, slightly antiseptic on account of the iodoform absorbed, and it is invariably sterile. We are careful, above all things connected with the use of catgut, never to draw our stitches too tightly, for fear of causing pressure necrosis.

Disinfection of Dressings. All dressings are disinfected in a steam sterilizer, two hours being given for steaming and one hour for drying. The same treatment is given to aprons, sheets, and towels.

Disinfection of Everything Coming Directly in Contact with Wounds. The basins, instrument pans, jars for dressings, etc., are boiled in soda and water for one hour, then wrapped in sterilized sheets until used. The tables are scrubbed with soap and water and then with 1 : 1000 corrosive sublimate in water. They are always covered with a double sterilized sheet when in use. The ordinary pads of cotton and of gauze, sterilized in a steam sterilizer, are used in place of sponges in all operations.

Drainage. Drainage is always used in very large wounds, such as breast amputations with removal of pectoralis major and

minor muscles and axillary glands, also in thigh amputations, usually only for two to four days, never in herniotomies, except strangulated hernia complicated with gangrene, nor in small clean wounds. The ordinary perforated rubber tube is employed.

It is always used in wounds which are primarily septic. In abdominal surgery we drain acute appendicitis cases if perforation or abscess formation has taken place. We always drain in gall-bladder operations and in suprapubic cystotomy; in pyosalpinx only if there is leakage of pus during the operation. Tuberculous joints are tamponed with iodoform gauze. In empyema of the chest we always carry two drains through the cavity, resecting one or more ribs behind and making an opening between the ribs in front.

We drain whenever there is any doubt as to the aseptic condition of a wound. We have found the use of an ordinary leather punch very convenient for making the necessary perforations in rubber tubing.

In the abdominal cavity we use glass tubes closed at the end, having a number of small perforations toward the lower end. A strand of gauze is carried to the bottom of the tube to act as a capillary drain. A piece of iodoform gauze, folded about four double, is placed over the glass tube, and the latter with this covering carried down to the point to be drained. In operations upon the pelvic organs it is carried to the bottom of the cul-de-sac of Douglas.

In removing gallstones from the common duct a rubber drainage-tube is fastened down upon the opening by means of an unchromicized catgut stitch, and a strand of iodoform gauze is sutured down upon the duct, above and below the opening, in the same manner. The same method is employed to drain the gall-bladder after removing gallstones in cases in which the organ is shrunken and cannot be attached to the peritoneum. This method, which was originated by Dr. Mayo, of Rochester, Minnesota, has been employed in many cases, and makes the otherwise serious operation of choledochotomy practically safe. This method is of such extraordinary value that I wish to emphasize it especially.

Irrigation. We practically never use irrigation during operations, either in the abdominal cavity or elsewhere.

During the early days of my surgical work as an assistant I observed that wounds in abdominal section healed more smoothly than in any other operations, and the only real difference in the treatment observable was the fact that no irrigation was used in connection with the former wounds, while it was invariably employed in others. I consequently applied the same plan of treatment to all wounds as early as 1889, and I have since constantly operated dry in clean cases, and since a number of years also in cases containing pus. We have treated wounds in circumscribed tuberculous lesions by applying strong compound tincture of iodine, and then sponging the area with moist gauze sponges before tamponing with iodoform gauze or before closing with sutures. These wounds have progressed well, but I do not feel convinced that the iodine has been responsible for this fact.

In tuberculosis of the joints we have applied strong carbolic acid to the exposed surfaces of the bones for two minutes, and have then washed these parts thoroughly with strong alcohol until all of the carbolic acid seemed removed.

I am convinced that irrigation is rarely of any real benefit and that it is frequently harmful in carrying septic material to portions which might have otherwise escaped infection.

In the treatment of wounds which come into the hospital in a septic condition we sometimes employ constant irrigation with normal salt solution.

My observations have convinced me that it is an exceedingly simple matter to obtain primary union almost invariably if one has a reasonable system—*i. e.*, a system which keeps the attention of operator, assistants, and nurses constantly on guard to prevent accidental contamination.

Whenever some new method is on trial in any hospital or clinic, everyone is interested, and, consequently, accidental contamination is not likely to occur. It is for this reason that the various new methods are so successful in the hands of their originators.

In having each successive assistant make observations every day

throughout his service we accomplish a very similar condition, because any case of even the slightest infection will be investigated, and all the conditions will be observed which might spoil the young man's comparative record.

Contact Infection. My observations have convinced me that the only form of infection which must be considered in surgery is contact infection. This is due to the introduction into the wound of septic material from unclean hands, instruments, sponges, or dressings, or from speaking or breathing into the wound.

It is such an easy matter to make instruments, sponges, sutures, and ligatures aseptic that there only remain the hands to account for. These can be made clean without difficulty and kept clean with proper attention, but it is this part of the system which is more frequently lame than any other. Everything that is to come in contact with the wound, the hands included, is usually clean when the operation is begun, but it is quite another matter to keep these clean throughout the operation, unless everyone connected with the operation learns to concentrate his attention upon the work at hand.

In this again simplicity is of great importance. The fewer persons who can infect the wound—*i. e.*, the fewer persons who come in contact with anything which in turn comes in contact with the wound—the less are the chances of one of these coming in contact with something which may not be aseptic and then again with the wound.

It is consequently best to have as few assistants as possible directly connected with the operation. In my own work I alone touch the wound with my hands, and that as little as possible; my first assistant uses hæmostatic forceps and sponges, and the second assistant makes the field of operation as accessible as may be by the careful use of retractors. I handle the instruments myself, and there is but one nurse connected with the operation, and she handles the sponges, drainage-tubes, dressings, as well as the sterile sheets, towels, and basins. The same nurse has assisted me in more than 5000 operations, and the same is true of my chief assistant.

Choice of Assistants. The assistants are graded in the following manner: one chief assistant, three second assistants, and six third assistants.

The third assistants are chosen from the graduating classes of the medical schools, and serve for a period of four months. From these the second assistants are chosen. The two from the year's list of eighteen who show the best practical qualifications receive the appointment of second assistants, their service being for a further period of eighteen months. Once in three years an assistant who has shown during his previous services as second and third assistant that he is especially fitted to become a surgeon is chosen for chief assistant. Each second assistant has two third assistants to aid him in all his duties. The latter have no responsibilities, however, and never come directly in contact with wounds.

The surgical head nurse is selected for her especial fitness for the work. She receives a suitable salary and remains in her position permanently. She prepares all the dressings, sutures, and ligature material, sterilizes the instruments, supervises the preparation of the operating-room and the patient on the day previous to the operation. She has three assistants, who are undergraduate nurses, whom she instructs, but who do not come directly in contact with anything which comes in contact with the wound.

Name.	Age.	Diagnosis.	Treatment.	Duration of disease.	Result.	Number of dressings.	Date of admission.	Date of discharge
Mr. Wm. S.	29	Fracture head of right humerus and subglenoid dislocation.	Incision, reduction; suturing of soft parts; drainage.	Injury occurred four weeks ago.	Aseptic throughout.	Seven.	Feb. 2	Mar. 6
Mr. E. H.	24	Chronic appendicitis.	McBurney incision, adherent and obliterated appendix removed.	Three months.	Primary union.	One.	Feb. 2	Feb. 23
Mr. F. A.	24	Right inguinal hernia.	Herniotomy; Ferguson's operation.	Four years.	Primary union.	One.	Feb. 4	Feb. 26
Mr. N. L.	62	Carcinoma of stomach.	Gastroenterostomy. (McGraw ligature.)	Five months.	Primary union.	One.	Feb. 4	Feb. 28
Master D.	11	Acute appendicitis.	Adherent, obliterated, and deeply congested appendix removed.	Two attacks; first attack eight mos. ago; second just recovered.	Primary union.	One.	Feb. 4	Feb. 29
Miss A. H.	16	Acute appendicitis.	Incision; removed adherent congested appendix.	One attack, two weeks' standing.	Developed phlebitis of left long saphenous vein; primary union.	One.	Feb. 7	Mar. 7
Mrs. A. C. W.	33	Chronic appendicitis; salpingitis; retroverted uterus.	Excision of adherent appendix, left tube, and ovary; shortened left round ligament.	Four years.	Primary union	One.	Feb. 7	Feb. 28
Mr. E. P.	20	Varicocele.	Excision of enlarged veins.	One year.	Primary union.	One.	Feb. 8	Feb. 23
Mrs. A. S.	36	Fibromyoma of uterus.	Enucleation of fibroid.	Two years.	Primary union.	One.	Feb. 8	Mar. 5
Mrs. J. C.	46	Exophthalmic goitre	Excision of left lobe (drainage).	Six years.	Aseptic throughout.	Five.	Feb. 9	Mar. 1
Mr. J. K.	32	Right inguinal hernia.	Herniotomy; Ferguson's operation.	Four months.	Primary union.	Two.	Feb. 9	Mar. 4
Mrs. S. K.	29	Pyloric obstruction; dilated stomach; distended gall-bladder.	Exploratory laparotomy; could not perform gastroenterostomy on account of abundance of fat in mesocolon and mesentery of jejunum.	Eight months.	Not dressed; patient died (cholæmia).	None.	Feb. 10	Feb. 19
Mr. C. B.	42	Carcinoma of stomach.	Gastroenterostomy. (McGraw ligature.)	Seven months.	Primary union; patient died of exhaustion.	One.	Feb. 11	Feb. 26
Miss I. J.	29	Omental adhesions.	Loosened omental adhesion to abdominal wall.	Three years.	Primary union.	One.	Feb. 11	Mar. 12
Mr. E. S.	32	Varicocele.	Excision of enlarged veins.	Seven months.	Primary union.	Two.	Feb. 12	Mar. 3

Mrs. R. K.	38	Intestinal adhesions; myoma of uterus; chronic appendicitis; pregnancy.	Excision of adherent appendix; removed two fibroids from right horn of uterus; loosened intestinal adhesion.	Patient ill several years; acute attack five weeks.	Primary union.	One.	Feb. 12	Mar. 24
Miss T. B.	29	Meningocele.	Excision double meningocele over base of occiput.	Since birth.	Aseptic throughout.	Dressing loosened by motion of head, necessitating eight dressings.	Feb. 14	Mar. 6
Miss A. L.	44	Carcinoma left breast.	Excision of mass together with pectoralis muscles and axillary glands; drainage.	Five months.	Aseptic throughout.	Eight.	Feb. 14	Mar. 8
Mr. I. T.	30	Acute appendicitis.	Excision of appendix containing pus.	Two attacks; last one four weeks.	Primary union.	One.	Feb. 14	Mar. 6
Mr. G. C.	29	Chronic appendicitis.	Excision of adherent and obliterated appendix.	One year.	Primary union, except for about 1 cm. in centre of wound.	Six.	Feb. 15	Mar. 24
Miss D. K.	25	Acute appendicitis; cystic right ovary.	Excision of œdematous appendix; punctured cysts of ovary.	One attack; three weeks.	Primary union.	One.	Feb. 16	Mar. 3
Miss C. M.	14	Submaxillary aneurism.	Excision, together with hemorrhagic submaxillary salivary gland.	Two weeks.	Primary union.	Three.	Feb. 16	Feb. 28
Mrs. S. R.	37	Chronic appendicitis; nephroptosis.	Excision of adherent appendix; sutured right kidney.	Floating kidney noticed for years.	Anterior wound healed primarily; posterior wound infected	Twelve.	Feb. 16	Mar. 20
Mrs. C. L.	49	Chondrosarcoma in right cervical region.	Excision; drainage.	Growth existed ever since childhood.	Aseptic throughout.	Eight.	Feb. 16	Mar. 6
Mr. C. P.	28	Acute appendicitis.	Excision of œdematous congested appendix.	Three attacks within nine mos; last attack one week previous.	Primary union.	One.	Feb. 16	Mar. 6
Mr. F. S.	24	Chronic appendicitis: subacute attack.	Patient had appendical abscess opened six years previous; appendix removed and adhesions loosened; drainage.	Several attacks since primary one.	Primary union.	Three.	Feb. 17	Mar. 12
Master T.	3	Right inguinal hernia.	Herniotomy; Ferguson's operation.	Congenital.	Primary union.	Two.	Feb. 17	Mar. 9
Mrs. M. H.	44	Salpingitis and adherent ovaries.	Both tubes and ovaries together with appendix excised.	Four years.	Primary union.	One.	Feb. 17	Mar. 18
Mrs. L. O.	31	Carcinoma of stomach.	Gastroenterostomy. (McGraw.)	Six months.	Primary union.	One.	Feb. 18	Mar. 28

Name.	Age.	Diagnosis.	Treatment.	Duration of disease.	Result.	Number of dressings.	Date of admission.	Date of discharge
Miss A. S.	23	Fibroadenoma of left mammary gland; chronic appendicitis.	Excision of fibroadenoma and adherent appendix.	Adenoma first noticed three yrs. ago; appendical trouble six mos.	Primary union.	Two.	Feb. 18	Mar. 13
Mr. W. J.	20	Chronic appendicitis.	Excision of appendix.	Three weeks.	Primary union.	One.	Feb. 18	Mar. 9
Mrs. R. B.	27	Intestinal obstruction post-operative.	Adhesions between loops of small intestine loosened.	Obstruction complete for twelve hours.	Primary union.	One.	Feb. 21	Mar. 20
Mrs. M. K.	29	Gastric ulcer; pyloric obstruction.	Gastroenterostomy. (McGraw ligature.)	Five years' standing.	Primary union.	One.	Feb. 22	Mar. 20
Mr. F. B.	23	Tuberculous lymphadenitis both sides of neck.	Dissected out lymph glands on both sides of neck; drainage.	Six months.	Aseptic.	Three.	Feb. 23	Mar. 12
Mrs. C. N.	36	Abdominal fistula, post-operative.	Dissected out fistulous tract; closed perforation in sigmoid.	Fifteen months.	Primary union.	One.	Feb. 23	Mar. 20
Mrs. M. R.	42	Myoma of uterus.	Abdominal hysterectomy.	Two years.	Primary union.	One.	Feb. 24	Apr. 2
Mrs. C. G.	34	Acute appendicitis; retroversion of uterus; salpingitis.	Excision of œdematous appendix, left tube and ovary; shortened round ligaments.	Appendical trouble six wks.; uterine trouble four years.	Primary union.	One.	Feb. 24	Mar. 26
Mr. F. S.	50	Pyloric obstruction; gastroenterostomy had been made four months previously; anastomosis opening contracted to 5 mm.	Enlarged old gastroenterostomy opening; resected jejunum above and implanted into side of small intestine (Murphy button); gastroenterostomy.	Five months.	Primary union.	One.	Feb. 24	Mar. 18
Mr. E. H.	40	Perforative appendicitis with acute peritonitis.	Exclusive rectal feeding twelve days; excision of perforative œdematous appendix.	Three weeks.	Primary union.	Two.	Feb. 25	Mar. 26
Mrs. A. A.	28	Chronic salpingitis; both ovaries cystic.	Appendix incidentally removed; excision of left tube and ovary; punctured cysts of right ovary.	Two years.	Primary union.	One.	Feb. 25	Mar. 22
Mr. C. J.	25	Acute appendicitis.	Excision of appendix; drainage.	Two months.	Primary union.	Three.	Feb. 28	Mar. 21
Miss R. P.	11	Perforative appendicitis.	Excision of appendix filled with pus.	Third attack since last September; last one two wks.	Primary union.	One.	Feb. 28	Mar. 20
Mr. A. A. S.	59	Carcinoma of stomach.	Gastroenterostomy. (McGraw ligature.)	Four months.	Primary union.	Two.	Feb. 28	Mar. 16

SOME STUDIES IN ASEPSIS.

By CHARLES HARRINGTON, M.D.,
BOSTON, MASS.

Occasional visits to operating-rooms have impressed me with the fact that, to some extent, surgeons are inclined to overestimate the importance of small possible dangers and to take more or less for granted absolute immunity from some others of greater magnitude. It was the unquestioning faith which some have shown in the instantaneous germicidal power of corrosive sublimate and other chemicals that gave me my first active interest in the general subject of asepsis and infection; and investigation of the actual value of a large number of these substances led me to consider other matters connected with operative work, including the danger of aerial infection, the sterilization of dressings and sponges, and the disinfection of the skin of the field of operation and of the surgeon's hands.

I shall never forget the look of utter consternation on the faces of all concerned when, one day, during an operation for hernia, I placed a sterile Petri dish upon a spot on the instrument table, about eight inches away from anything lying thereon, in the belief that the surgeon, by whose invitation I was to make certain observations, had arranged for the same with his colleagues. One would have supposed that that innocent dish was a seething mass of infection, fully prepared to disseminate the germs of septicæmia in all directions, even as a pinwheel throws its sparks. A hurried consultation was held, while I made my excuses and attempted to explain the absence of real danger. The result was the covering of that end of the table and the dish with a sterile towel. At this stage of the case my culpable partner entered and explained

matters, whereupon the towel was removed, the culture medium in the dish was exposed, and the operation proceeded. At the close of the operation the dish was removed and incubated. The result demonstrated that upon each square inch of the dish, and, inferentially, of the table and of the instruments thereon, and presumably of the field of operation, no less than 120 organisms, chiefly pus cocci, were deposited from the air in the course of an hour. It is not for me to say how much danger may reside in such a shower of bacteria. Frankly, I do not know, nor does there seem to be any unanimity of opinion on the part of those who have investigated the question of aerial infection; but it seems to me that the subject is not generally considered to be of such importance as the possibility of infection from sweat or from the introduction of an occasional bacterium from the superficial or deeper layers of the skin or from other sources. It has seemed to me that the danger of infection through the escape of droplets of sweat of a carefully prepared hand through an accidental puncture of a rubber glove is accorded undue weight. I have read numerous reports of experiments concerning the infectivity of sweat, and most of them have impressed me as unwarranted in their conclusions, owing to faulty premises and technique. In a recent article on the subject it is dogmatically asserted, "The purest of sweat is impure; it is never sterile." With that statement I take issue. Six different times in my laboratory sweat has been made to flow from well-cleaned, and, so far as is possible, sterilized forearms and hands encased in sterile glass cylinders heated by appropriate means; and in not a single instance could a bacterial growth therefrom be obtained. Moreover, injections thereof in fairly large amounts into animals—subcutaneously, intravenously, and intraperitoneally—were quite devoid of results. That there are bacteria in the various layers of the skin and in the hair follicles, there can be no doubt; but that they exist in the sweat glands, from which the outflow of secretion would tend to bar them, is by no means clear. Indeed, I am informed by a number of our leading pathologists that an infection starting in a sweat gland is exceedingly rare.

Of far greater importance, it seems to me, is the danger of

infection through saliva. Repeatedly have I seen surgeons, even in abdominal cases, talking directly into the wound. Now, it has been demonstrated by Flügge, of Breslau, and by several others that, in ordinary conversation, there is a constant throwing out of minute droplets of saliva, some of which are projected laterally several feet. They are expelled in great numbers in the use of words or syllables beginning with the consonants *d*, *k*, *p* and *t*, the formation of which involves the sudden explosive liberation of air held in the mouth under pressure. They may be sent forth as numerously during whispering as with loud speech. Now, the mouth cavity is a singularly unclean place, for the secretions of the mouth are likely to be richer in bacteria than the foulest sewerage, and these bacteria are largely staphylococci, diplococci, and streptococci, and are likely to be exceedingly virulent. In one series of experiments, recently published, the average number of organisms per droplet of saliva as cast out in ordinary speech proved to be no less than 4375. Is not, then, the danger of infection by this means entitled to greater consideration than that more or less imaginary one of infection through sweat?

That the deeper layers of the skin yield bacteria is a well-known fact, but the mere obtaining of positive results from inoculating culture media therewith is no proof of their harmful nature. Indeed, several of the species commonly present are known to be non-pathogenic.

In speaking of these several matters I have no intention of advocating any lessening of the precautions taken to bring the danger of infecting the wound to a minimum, but I wish to point out the inconsistency of paying so great an amount of attention to the possibility of introducing bacteria, many of them harmless, from one source and another, and neglecting that of the introduction of others, perhaps more dangerous, that are showered down through the air and projected from the mouth. I have made numerous exposures of Petri dishes to the air of operating-rooms, and in every instance the great majority of the colonies produced have been of pyogenic organisms. The numbers deposited have varied widely, the maximum being 131 per square inch per hour.

In his work in the operating-room the surgeon is dependent to a great extent upon the care and thoroughness with which others, whose work he necessarily cannot supervise in every detail, carry out their part. He must assume that the dressings and sponges have been prepared with scrupulous care. He is, in a way, at the mercy of those in subordinate positions whose carelessness or want of proper instruction may vitiate his best endeavors. To emphasize this point I will give two illustrations:

The sterilizing plant of a hospital is to me always an attraction, and whenever I visit one I inquire into the methods followed. I was present one day in a room fitted with as perfect a lot of apparatus as one could wish to see. The person in charge had packed one of the autoclaves with dressings, which were wedged in so tightly that one could find hardly a space between them large enough to admit even a finger. On my asking what measure of sterility was expected with such solid packing, I was informed that absolute sterility would be attained in an hour, the steam being under fifteen pounds' pressure. Anybody who has ever studied steam disinfection scientifically is aware of the great necessity of loose arrangement of the objects under treatment, in order that the steam shall have as free access as possible to every part, and that the readiest means of preventing its action is solid packing.

In an autoclave in another institution, I saw a number of sponge jars with their lids in place. I ventured to open one of them, and found that the cover fitted so tightly that some little force was necessary for its removal. I asked the attendant if the sponges therein contained were to be sterilized by steam or by dry heat, and the answer was "Steam." But it was obvious that the steam could not gain access to the interior of the jar, from which, moreover, the contained air could not escape. I received permission to test the matter practically. The contents of the jar were replaced by a number of sponges which I infected with a twenty-four hours' culture of staphylococcus pyogenes aureus. The cover was then put on, and the whole was subjected to the routine process. Cultures of the sponges were afterward made in sterile bouillon

and incubated for twenty-four hours at 37° C. The results were positive; sterilization had not been effected.

On the other hand, in some hospitals the sterilization of dressings and sponges is carried to an unnecessary degree of thoroughness, which involves wasting much valuable time. I refer to fractional sterilization. Fractional sterilization of such materials as milk and culture media is necessary, on account of the presence of sporing organisms in a fluid rich in nutriment. The ordinary temperatures employed destroy the bacteria, but the spores resist, and during the next twenty-four hours they develop into bacteria, which are destroyed by a second heating; and a third treatment ensures sterility beyond a doubt. These spores, by the way, are those of certain non-pathogenic organisms; the most resistant pathogenic spores are killed by a few minutes' boiling. But in the case of dressings treated properly with steam under pressure, both the bacteria and the spores present are destroyed with one exposure, for even the very resistant non-pathogenic spores above mentioned cannot resist steam under fifteen pounds' pressure for ten minutes. But supposing they could, what effect would a second treatment on the following day have upon them? None whatever, for in the absence of moisture and nutrient material they could not develop into bacilli, and so long as they remained spores they would, within reasonable limits, retain their resistance. So a second exposure would be as futile as the first, and a third, fourth, and fifth would be equally barren of results.

Carried out with proper precautions as to packing and vacuum formation, sterilization of dressings and sponges require but one exposure to steam under fifteen pounds' pressure for thirty minutes at most. Indeed, I have placed dried cultures of staphylococcus aureus and staphylococcus albus in the pockets and sleeves of two coats rolled loosely together, and have attained sterility in ten minutes with steam under ten pounds' pressure.

The preparation of the hands for surgical work is a subject that has interested me greatly. The potassium permanganate-oxalic acid portion of the process has always excited my wonder. Three explanations have been given me of the necessity or advisa-

bility of this treatment, namely: 1. That the permanganate destroys bacteria. 2. That it oxidizes the organic matters adherent to the skin. 3. That when one stains the hands in every part with permanganate and then removes the stain with oxalic acid the hands are clean. As to the assertion that it destroys bacteria: I have experimented with saturated permanganate solution against staphylococcus aureus and albus, B. coli, and B. pyocyaneus, and have found that ten minutes' exposure is ineffective against all but the last mentioned. These results were obtained not once, but several times. As to the oxidation of organic matter: Potassium permanganate is pre-eminently an oxidizer of organic matter. On dipping the hands into a saturated solution they are stained a deep brown, owing to the precipitation of a lower oxide, oxygen having been given up to the epidermal scales and other organic matter. This deposit of the lower oxide is soluble in oxalic acid, which thus restores the normal color of the hands. It is assumed that the organic matter (just what harm it will do unless it is in the form of bacteria I do not know) is completely oxidized and disposed of. Dip the hands, however, a second time, and see what happens. The same thing. Repeat it. Again it happens, and again, and again, and again. This is due to the fact, that, immediately on contact with organic matter, the permanganate is reduced and the hands become, as it were, plated with the precipitated lower oxide, which acts as a bar to further action of the permanganate upon the parts immediately beneath the plating, just as the albuminate of mercury prevents the further action of corrosive sublimate. A short time ago, I tried the experiment of treating my hands first with permanganate and then with oxalic acid and repeating the process until further treatment failed to give the characteristic brown stain. On the twenty-first trial, the stain was observed to be less intense, and so on to the twenty-fifth, when the experiment was discontinued. From this it would appear that to oxidize all the organic matter possible by this means is an endless task. After twenty-five treatments, I washed my hands with soap and water, and after repeated rinsing in running water I dipped them again into the permanganate

solution. At once the original dark-brown stain appeared as intensely as ever. I was then oxidizing the traces of soap, which, in spite of continued rinsing, adheres tenaciously to the skin, as is proved by the great difficulty one observes in removing, by rinsing, the odor of a scented soap after washing therewith.

As to the statement that a hand once stained and decolorized is necessarily clean, there is but little to say. A dirty hand may be stained and decolorized as well as a clean one, but the dirt remains. Permanganate removes no dirt and destroys only weakly resistant bacteria.

After thorough brushing with hot soapsuds, what agent can be relied upon to kill the bacteria that have not been removed? Not corrosive sublimate, 1:1000, if we soak the hands a quarter of an hour; not creolin, 1:20, if we soak them much longer; not lysol, nor solveol, nor bacillol, nor sulphonaphthol; not peroxide of hydrogen; not sublamin; not mercuric cyanide; not even formaldehyde in 5 per cent. solution, even though the skin could stand it. All of these agents and several others I have tested under the most favorable conditions against the common pus organisms, and all failed to kill within reasonable periods. Without going unnecessarily into details, I will give my results as briefly as possible. A little more than a year ago, I published the results of a series of experiments which demonstrated that corrosive sublimate 1:1000 requires more than ten minutes' contact to kill staphylococcus albus, and that weaker solutions (1:5000) act far more slowly. Recently I tried 1:500, which solution is too strong and irritating for general application, and found that it would kill staphylococcus aureus in from sixty to ninety seconds, and the other pyogenic organisms in from forty to sixty seconds. With 1:100 I found that the aureus was killed after twenty seconds. Now, if 1:100 cannot destroy pus cocci in twenty seconds, and 1:500 can do so only after a minute, and 1:1000 only after ten minutes, what measure of disinfection does the surgeon attain who merely dips his hands into the solutions of corrosive sublimate in common use for only a few seconds, and then rinses them off with sterile water or salt solution?

In my tests of the germicidal power of other disinfectant solutions, I employed a number of different species of bacteria; but in the brief report of results now to be made, I will deal only with that pyogenic organism which is most common and also the most resistant—staphylococcus pyogenes aureus.

The following table shows the number of minutes that the organism mentioned remained in contact with the several disinfectants without injury, and also the shortest exposure observed that was sufficient for its destruction. The intervals adopted were as follows: thirty seconds, one, two, three, four, five, seven, ten, fifteen, thirty, forty-five, and sixty minutes. In only one case was the exposure longer than sixty minutes, and then the agent failed to kill in three hours.

Agent.	*Strength.*	*Failed to kill (minutes).*	*Killed (minutes).*
Carbolic acid	1 : 40	3	4
" "	1 : 20	1	2
Trikresol	1 : 40	2	3
"	1 : 20	1	2
Lysol	1 : 40	7	10
"	1 : 20	2	3
Solveol	1 : 40	10	15
"	1 : 20	10	15
Bacillol	1 : 40	4	5
"	1 : 20	3	4
Creolin	1 : 40	10	15
"	1 : 20	10	15
Sulphonaphthol	1 : 20	30	45
Hydrogen peroxide	Full strength	4	5
Formaldehyde	1 per cent.	60	
"	2 "	30	45
"	3 "	25	30
"	5 "	15	20
Mercuric cyanide	1 : 1000	180	
Sublamine	1 : 1000	10	
Potassium permanganate	Saturated	10	15
Potassium permanganate and hydrochloric acid (Andrews')	1 per cent. each	4	5

Here, then, are twenty-two preparations, not one of which acts under two minutes, and most of them only after five.

My next endeavor was to find some preparation that will kill

not in minutes, but in seconds. It was obvious that none of the organic compounds mentioned could be depended upon to do this in any strength which it would be practicable to use, and I had, therefore, to turn to the inorganic agents. Of the salts of the metals, corrosive sublimate is beyond question the most powerful, but this cannot be depended upon in its usual solutions, as I have already pointed out, and so it must be combined with some other agent or agents, if any increase in effectiveness is to be secured. The addition of hydrochloric acid to the extent of 10 per cent. was found to be very effective, but a solution of an irritant like corrosive sublimate with another like hydrochloric acid would obviously be out of the question, on account of its local action; but if this action could be prevented, the combination might be useful. First, I experimented with a mixture which I found to kill St. aureus, albus, and citreus, and B. pyocyaneus in less than ten seconds. Then for some time I tried weakening it, first as to one, then as to another ingredient, but always aiming to keep its limit of required time at about ten seconds. The ninth combination tried appeared to be as weak with respect to each of the active constituents as could be made, but retaining that degree of efficiency—that is, to kill the pyogenic bacteria on silk threads within ten seconds. I tried it against pus from a carbuncle and against two specimens of uncertain origin, and at the same time I tried carbolic acid and trikresol, which had proved to be the quickest in action of the twenty-two solutions above mentioned. Let me say here that killing bacteria in pus is quite a different thing from killing them on threads and glass beads.

The carbuncle pus was killed by trikresol (1:40) in five and one-half minutes, and by carbolic acid (1:40) in four minutes. My mixture killed it in less than a minute, though not in thirty seconds. The other specimens of pus were both killed by trikresol and carbolic in two minutes, and by my mixture in less than thirty seconds.

Following are the results of attempts to sterilize the skin. I have repeatedly soaked my hand (without any preliminary scrubbing) for two minutes, and then have had plantings made from

material removed from about each nail and from scrapings from the skin of each finger and from the palm. Occasionally I got a growth, but, as a rule, every tube of bouillon remained clear and sterile. A young man whose duties included the daily cleaning of cages in the animal room and whose hands were not the subject of much thought or care, soaked his hands (after ordinary washing) on ten different occasions for from two to five minutes, and each time each nail and finger was tested—*i. e.*, ten cultures were made. In seven of the experiments there was entire absence of growths; in one a growth was obtained from one forefinger; in one from one middle finger, and in one from one thumb. That is to say, of one hundred plantings only three showed growths.

At the Boston City Hospital, Dr. Monks immersed his hands for two minutes without previous scrubbing; the skin of both hands gave negative results, but growths were obtained from the nails of the right hand; the nails of the left hand were sterile. Three of the assistants did the same thing, but after scrubbing, and with these results: Dr. H. Left hand sterile; nails gave growth; right hand sterile; nails sterile. Dr. K. Left hand sterile; nails sterile; right hand sterile; nails sterile. Dr. S. Left hand sterile; nails sterile; right hand sterile; nails sterile.

Examination of the skin of Drs. H. and K. after being engaged in operating showed persistent sterility, but Dr. S.'s left hand yielded a growth. The mixture has been used also in several cases of lacerated wounds.

For my combination I make no claims whatever and no assertions that later might have to be recalled. I submit the facts as I have seen them. I do not say that everybody will get the same results that I have seen. To my hands and to those of my assistants the mixture has caused no irritation beyond the same degree of biting that one notices when in contact with peroxide of hydrogen. Two of the surgical assistants reported slight exfoliation two days after trying it, but nothing more. I recognize that some skins may be more markedly irritated and that not sufficiently numerous experiments have been made to warrant unqualified recommendation.

The composition of the mixture is as follows: commercial alcohol (94 per cent.), 640 c.c.; hydrochloric acid, 60 c.c.; water, 300 c.c.; corrosive sublimate, 0.8 gram.

This mixture, then, contains 60 per cent. absolute alcohol; 6 per cent. commercial (strong) hydrochloric acid, and 1:1250 corrosive sublimate. Now, 60 per cent. alcohol will destroy staphylococcus aureus in four minutes; 10 per cent. hydrochloric acid is equally effective, and 1:1000 corrosive sublimate will kill it in three minutes. Why a combination containing all these substances but with lesser proportions of the acid and the salt is so much quicker in its action than any one of them alone, is an interesting question of physical chemistry.

DISCUSSION ON THE PAPERS OF DRS. MONKS, OCHSNER AND HARRINGTON.

Dr. De Forest Willard, of Philadelphia.

We are all under great obligations to Dr. Harrington for his accurate experimental researches upon this subject, since it is exceedingly important that this experimental work be done in a thoroughly scientific manner. Those of us who have to deal with the practical side of asepsis in surgical operations know that our results satisfy us to a certain degree, but we must confess we do occasionally have failures, and it is very essential to know whether our failures lie in the methods employed or whether there are difficulties which cannot be overcome. Faulty or careless procedure may produce a flaw in the chain of technique, consequently the question resolves itself into one of definite and extreme care on the part of everyone, from the surgeon down to the lowest assistant nurse.

I think there can be no question as regards the position taken by Dr. Ochsner, that a hospital which has permanent assistants and permanent nurses is the one that is likely to secure the best results from operative procedures upon the patients under its care. But there is another side that ought to be considered by every teaching surgeon, and it is this: Are we not, as surgeons, responsible for the surgical care of the next generation, just as we are responsible for the hygiene and for the medical care of the community? The training of students and of the younger men of the profession is a part of the duty of the surgeon. His first duty is to his patients, but he has a second duty to the public. The training of our young men is a very important part of the work, particularly as to surgical cleanliness—the formation of the aseptic habit. All of us were young once; all needed training. Teaching alone is not sufficient; practical application of methods is all important. I thoroughly believe that the best immediate results will be obtained by a permanent staff, but in the majority of hospitals the passing of knowledge from one individual to another is essentially a part of the future surgical safety of the community, and will secure the greatest good to the greatest number.

With regard to the use of different antiseptics, one surgeon will use a certain solution and obtain equally good results with the one who uses another solution, since, after all, it is largely a matter of cleanliness. Some of us can use bichloride of mercury in stronger solutions than others; some of us can bear carbolic acid only in weak dilutions. The mixture that Dr. Harrington has proposed will probably, in a certain

number of cases, be exceedingly valuable; but some skins will be irritated by a mixture of the kind mentioned. Its permanent success will depend upon experimental testing in a large number of cases.

One point brought out by Dr. Ochsner is an exceedingly important one, namely, that an operating-room on the first or second floor of a hospital is in a dangerous position. I think we ought to operate on the top floor of the building, whether it be three or ten stories high, for the reason that the farther we are from the ground the less dust will be encountered and the air will be less contaminated. It is interesting to note in the papers read this morning that the pendulum of opinion is swinging back again to Lister's original proposition that infection of wounds comes largely through dust in the air. It was to avoid this method of entrance that he was induced to use the spray. The spray, while unnecessary and sometimes dangerous, was nevertheless an important step in the evolution of antisepsis, and those of us who employed it know that excellent results were obtained under its use.

Dr. Charles B. Nancrede, of Ann Arbor, Michigan.

I wish to preface my remarks by saying that I was one of the very earliest to adopt in this country the modern methods of wound treatment. I am not, of course, foolish enough to claim priority, although perhaps I have a right to. I have been watching with a great deal of interest the innumerable papers, the recommendations, and statements made in the last twenty-five or thirty years—yes, more than that, thirty-five years—and the trouble, it seems to me, is that we are dealing with these questions in the superlative degree. On one side of this question one set of men will say that it is absolutely essential for us to adopt such and such measures to secure asepsis in surgical operations, while another set of men claim that these measures are not at all essential. The root of the trouble is that but few who are both practical bacteriologists and practical surgeons talk on this subject.

It is extremely interesting to me to have heard these excellent papers and to see how essentially old ideas and experiments are repeated in them. The trouble is that few seem to really understand the principles of asepsis, and, as a consequence, one lays too much stress on one thing, and the next writer too little on another. The fact of the matter is, anybody can get aseptic results with anything or with nothing but hot water and "elbow grease." But the man who does not understand the principles underlying asepsis, although he may say he does, will make the sweeping assertion that this measure is no use, but that his scheme is infallible. Circumstances alter cases. One class of men, with one set of trained assistants, can do things another set cannot

accomplish with their different environment. When the leaders of the profession make positive statements, without properly qualifying them, as, for instance, clearly explaining the peculiarities of their environment, which render proper and possible the omission of some of the well-recognized aseptic precautions, they do serious harm, for we have to educate men who do not recognize their limitations. As a matter of fact, there are many things that are useless for the expert surgeon with expert assistants, which are essential for the non-expert.

I have not heard a word said in regard to two important points, one of which is inhibition of germs, and the other tissue resistance. I have heard much to-day of destruction of germs, but nothing of the reduction of their virulence until they are practically inert, although capable of slow growth. I can prove both clinically and bacteriologically that a germ that is not killed is often inhibited. It may be inhibited to the point that will render it safe in a given wound. Again, the resistance of the tissues of a wound determine the success or failure of attempted asepsis. Given lowered resistance, and you will have infection by methods which prove perfectly aseptic when tissue resistance is normal or exceptionally great.

I must again urge upon the Association the fact that these points and many others of great pertinence have been thrashed out again and again, as we have been doing to-day, both in the laboratory and in the clinic-room, and it is only the principles we should lay stress on. I have not heard a statement as to why these widely differing plans are so essential except by inference in one or two instances. We should not forget that many of us are teachers, hence that many of our statements go out carrying with them great authority, as they should; but sometimes when they go out, or ought to go out, with great authority, they are not so received, because of the shortcomings I have pointed out. It is a great pity that we will make such positive assertions without qualifying them in such ways that no possible misapprehension can arise.

Dr. John E. Owens, of Chicago.

We all know that very different results are reported by different surgeons after using the same method, and I have often wondered whether some of them may not have been due largely to the habits of the surgeon. For instance, we often see one unwittingly handling his feet; we may see another in the daily walks of life, travelling on street cars and in other ways without gloves, and his hands thus become soiled. Our hands become soiled by the balustrades in buildings, in elevators, and it has seemed to me that more uniform results may be realized by the adoption of more cleanly habits. Gloves should

be worn habitually. Of course, we do not expect the wearing of gloves will sterilize the hands or keep them so, but it will certainly obviate sources of contamination to some extent.

I hardly know what to say relative to the management of our assistants in hospitals where the service changes quarterly. In St. Luke's Hospital, Chicago, we have a different set of assistants at the end of every three months, and by the time one set is broken in, so to speak, they have to give way to another. Not long since, just before beginning an operation, I had to send my first assistant away from the operating-table in consequence of dirty finger-nails.

A large part of the profession in general seems awry on the subject of antiseptic surgery. Not long since, when about to operate on a patient who had been brought to the city of Chicago for that purpose, I was a little delayed, but when entering the preparation-room I found three visiting medical men busily engaged in scrubbing their hands. They had passed the nurse in some way; had their coats off, and sleeves stripped up, scrubbing away vigorously, when not one of them was to come within six feet of the subject. Of course, our basins, etc., after these gentlemen had finished required the attention of our nurses. One of the gentlemen, a man with a long, flowing beard, asked the nurse if she would not tie up his beard with gauze. That might be a good thing in a gentleman with such a beard as he had, but the rank and file have a wrong conception of the appreciation of the principles underlying asepsis in surgical operations. Assistants and those who take part in operations need to be watched carefully, as they are liable to scratch some part of the face, pick up something, or do something they should not do; consequently it keeps the surgeon continually on the watch unless he is fortified, as is my friend Dr. Ochsner, with assistants who have undergone a training of five years. So we have many things to contend with, and we need to be continually on the alert concerning internes and other assistants.

A few years ago I was obliged to discontinue the use of corrosive sublimate and carbolic acid for the reason that my hands became eczematous and otherwise irritated. Since that time, by scrubbing my hands thoroughly with soap and water, cleansing the nails, keeping them well pared down, and afterward washing with boric acid or boro-salicylic solution, and, finally, with alcohol, my results have been as good in hospital work as they were when stronger chemical sterilization was employed.

Dr. W. W. Keen, of Philadelphia.

In the first place, I would like to say a word or two in reference to my own methods and the results which have been obtained by some

experiments. I have adopted for several years past for cleansing my hands the method which was first called to our attention by Weir, namely, bichloride of lime and carbonate of soda. First, the hands are washed thoroughly with soap and water, and in order to do this I have in my own private hospital and at the clinic at the Jefferson little "egg-boilers," which are practically hour-glasses or sand-glasses that are reversible and cost only twenty-five cents apiece. They can be bought at any house-furnishing store. They are marked "soft boiled, "well done," and "hard boiled." Soft boiled corresponds to about three minutes; well done to five minutes, and hard boiled seven minutes. I tell my assistants that when they have scrubbed their hands until the the sand has reached "well done, good and faithful servant" (five minutes), they may stop.

Every person who takes an active part in my clinic has a culture taken from under the thumb-nail and one or two finger-nails, and at the root of the nails and from the free surface of the skin of the hand. During last winter there were 213 cultures made from the hands of myself and my assistants in the clinic at Jefferson. Of this number, there were only seven instances in which any culture was obtained. That makes practically a sterility in 97 per cent. and an infection in about 3 per cent. There was but one person who was free at every clinic, and that was the head nurse, who is a permanent official in the operating-room. All the other nurses and all the assistants, except my principal assistant, change every three months. My own hands were infected once. In order to obviate this occasional infection, after using the chloride of lime and carbonate of soda and taking the culture, all of us scrub the hands for a minute in sublimate solution 1:1000. I think keeping such a record of every person's hands serves an admirable purpose by creating a sort of rivalry among us to have clean hands.

Dr. W. B. Coley, of New York City.

I have been very much interested in these papers, and there can be no doubt that the improvements in the technique of aseptic surgery are along the line of simplicity. I wish to relate briefly some experimental work we have been doing at the Hospital for Ruptured and Crippled, New York, and I would like to say I do not believe Dr. Monks laid sufficient stress upon sterilization of the skin, and, although some authorities believe it can be done properly in a few moments before operation, our experiments show that with careful preparation the day before operation, in addition to what is done on the day of operation, sterilization of the skin even then cannot be perfect. In 250 cases in which we had examined portions of the skin, or Reverdin grafts

taken from the field of operation immediately before, twenty-five, or 10 per cent., of the cases showed all kinds of cultures, some of them being staphylococcus and streptococcus. The only case of suppuration that I had in a series of 200 cases showed a pure culture of the streptococcus, and the abundant suppuration which followed operation showed a pure culture of the same organism. Carefully sterilizing the hands, using tincture of green soap applied thoroughly by brushing and hot water, then washing thoroughly with 95 per cent. alcohol, with the use of rubber gloves, will give us as perfect results as any of the measures which render the hands very hard and rough.

In regard to primary union, I believe an important element in aseptic surgery is to guard against the bruising of tissues. We have had the house surgeons perform operations at the Hospital for Ruptured and Crippled who have gone through the same careful preparation of the skin and hands, wearing sterile gloves, yet taking twice or three times as long to perform operations. The bruising of the tissues in almost every instance was followed by suppuration.

A CLINICAL REVIEW OF FORTY-SIX OPERATED CASES OF DUODENAL ULCER.

By CHRISTOPHER GRAHAM, B.S., M.D.,
ROCHESTER, MINN.,

AND

WILLIAM J. MAYO, A.M., M.D.,
ROCHESTER, MINN.

THE MEDICAL SIDE.

The basis of diagnosis of duodenal ulcer is the carefully developed history. Physical and laboratory findings are helpful accessories.

In our series pain was, perhaps, the most important symptom and had some characteristics. It may be sudden, sharp, and severe, and be manifest to the right of the median line, but rarely radiates beyond the stomach and duodenal area. As a rule, it has decided relations to meals. There is, however, a small group in which food plays an unimportant part. It includes those cases where peritonitis, due to complete or partial perforation, gives the first symptoms, where there is no motor insufficiency due to either spasm or obstruction, and where the gastric contents are not above normal in acidity. Food most often gives relief for a time, the pain appearing from three to six hours later; in other words, when the stomach should be nearly or quite empty. Pain appears daily or several times a day during the period of attack. In the great majority of cases it is entirely quieted or modified by food, drink, vomiting, irrigation of the stomach, and alkalies. Pain of duodenal ulcer cannot be due to food directly; it rarely comes sooner than two hours after food enters the stomach,

and much oftener four or more hours later, and the kind of food usually plays an unimportant part, if we exclude salts and acids. The pain is due chiefly to two factors: (*a*) In this class of cases it is due to peritonitis caused by a greater or less degree of perforation, and it simulates gallstone colic. (*b*) This comprehends the greater number of cases, and the pain is due almost wholly to the irritant action of the acids on the open ulcer, with the added element of spasm. The greater the quantity of the liquid in the stomach and the higher the degree of acidity the more severe the pain. In other words, intensity of pain and degree of acidity run about parallel. The irritant action of the food as a cause of pain by passage over the diseased area cannot enter into the question, because anything that diverts, dilutes, neutralizes, or removes the acid liquid lessens or entirely relieves the pain. Food and drink, by diverting and diluting, bring relief; antacids as a rule quiet for a time and remove nothing; vomiting or irrigation of the stomach relieves by removing the offending acid, but no rough particles of food which could irritate are found so long after a meal in either vomitus or washings, and both are as a rule abundant. Tender spots are infrequently found, and when present they are to the right of the median line in the duodenal, gall-bladder, and pyloric area. Posterior tenderness was seldom demonstrated.

Vomiting was a prominent symptom in our series, 32 giving it important mention. The chief points of vomiting are the time, the form, and the kind; that is, first, whether soon after taking food, or deferred quite late; second, whether of small amounts and regular, or only occasionally, or whether more or less irregular, and quantity large; and third, whether food is vomited as taken, or only eructations of hot water, small, sour, bitter amounts, intensely acrid, and large amounts or quantities of half-digested, macerated foods. In these cases vomiting as a rule is delayed, irregular, and acrid, not much food contained in it except when obstruction had obtained in a decided degree. The quantity varied, it being decidedly abundant in the latter. Relief came through vomiting, and the patient often induces vomiting to

quiet distress or intense, burning pain. When there was a history of hypersecretion the amount was usually large and digestion well advanced. In other cases the amount was small if obstruction was not pronounced. The characteristics of vomiting in these cases seem to be: coming later after food, acid liquid or liquid food well digested and more or less irregular in time, and relief following evacuation of the stomach.

Gas is also an equally important symptom here, and seems to be at its height when acidity, pain, and vomiting are ascendant, and relief by food and drink comes to gas formation quite as frequently as it does to pain. We feel sure that gas is more prominent as a symptom in ulcer of the duodenum or pylorus than ulcer at any other location, and certainly it ought to be, as gas formation is first to herald motor insufficiency of whatever nature, and in this position slight narrowing would soon demonstrate its presence, and spasm could easier here become effective. Acidity beyond normal is the rule, and was excessive in 13 of 24 cases, and this increased acidity is a frequent cause of gas formation. Dilatation was much more often found than normal capacity.

A very large proportion (32) have good appetites, nay more, most of them have keen food desire, and only pain, gas, vomiting, and acidity prevent sufficient food intake. Many are found undergoing voluntary dieting, but more often fail to secure that relief which usually comes to those whose trouble is of the stomach proper. We certainly expect the appetite to be good in cases where the digestive juices are normal or abundant, and this is the rule in duodenal ulcer. Constipation is a common symptom, and was most bitterly complained of by one-fourth of the number, four charging most of their trouble to this.

Bleeding of duodenal ulcers is common, and may be characteristic. It led to a diagnosis in one case when the passages were frequently dark and tarry, or even bloody, and no pain was experienced. Twelve reported blood either by vomit, stools, or both, and in four instances it was found at test meal when not otherwise mentioned.

Latency of duodenal ulcer has been often demonstrated, and

is believed to be much more common than latency of gastric ulcer. It would seem that three factors influence latency: first, if acidity is low or not above normal; second, if no motor insufficiency is present; third, if perforative peritonitis has not taken place. Under these circumstances there will be no pain, no gas, no vomit, and the pathological condition will go unrecognized by the patient, and of course by the clinician, unless hemorrhage reveals the true condition. These factors have weight if the ulcer locates itself at or near the pylorus or along the lesser curvature. These latent gastric forms are prone to heal, and cancer may quite as readily follow in their wake as in that of the chronically open ulcer.

The 46 cases are placed in five groups, the division being made in the light of the operative findings.

The first group contains 4 cases, with a history of stomach or gall-bladder type, or both, for periods of from four to twenty-one years, and came to the hospital with acute perforation of chronic ulcer. Of these, 1 was referred to us as acute perforative appendicitis, and our diagnosis was gallstones with recent rupture of the gall-bladder, and 1 was sent to the hospital for ruptured gall-bladder, and a differential diagnosis was made on three points: (*a*) a history of from fifteen to eighteen years of bitter trouble from *gas formation* two to six hours after meals; (*b*) large amounts of morphine necessary to control the pain (of perforative peritonitis); (*c*) mass, tenderness, and rigidity well to the right. Of the other 2 cases, one was diagnosed as gallstones with perforation, and the other reached the distinction of being called either perforated gall-bladder or perforated duodenal ulcer.

Group two consists of 1 case of chronic repeated hemorrhage by the bowel over a period of three years, with repeated acute bleedings for four weeks previous to admission, and for which he was operated upon. In this case the correct diagnosis was made from the hemorrhages, for the stomach symptoms were among the mildest of the whole class.

In the third group there are 25 cases. Nine had separate ulcers

in the duodenum and stomach; in 15 the ulcer was continuous from the duodenum to the pylorus, rarely to the stomach. Of this number 16 were diagnosed ulcer of the duodenum or pyloric end of the stomach, the diagnosis in many cases favoring the duodenum as the probable seat. Pain, vomiting, gas, acidity, dilatation, constipation, and appetite characteristic of ulcer of the duodenum (or pyloric end of the stomach) predominated, the degree of the attendant motor insufficiency measuring in most instances the severity of the symptoms. In 8 of the cases under group three the symptoms were such that a diagnosis of "ulcer or gallstones" was made. Tenderness to the right and sudden attacks of pain, more or less irregular, were experienced. Definite signs of motor insufficiency, often lasting only a short time, were clearly present. However, the whole "symptom complex" seemed not incompatible with either gallstones or duodenal ulcer, or both. Another of this group was diagnosed as gallstones a year previous to operation, and the diagnosis was not changed when she entered the hospital, though stomach symptoms had developed in the last four months.

Under group four we find 8 cases of chronic perforation. One of these had been diagnosed as gallstones and operated upon a few months previous, with negative findings; finally ulcer was decided upon, and a gastroenterostomy relieved. Two others were sent to the hospital with a diagnosis of cholelithiasis, and only ulcer found. Another, in which the diagnosis of gallstones had been made three years previously, presented symptoms of ulcer so decided that a diagnosis of probable duodenal involvement was made. Both gallstones and ulcer were found. The remaining 4 cases had severe spells that in the present light would indicate perforative peritonitis; they gave decided symptoms of gastric disturbance, with temporary periods of motor insufficiency, accompanied by more or less dilatation, and were fairly diagnosed as ulcer, with only a suspicion of gallstones.

Group five includes 8 cases that were purely duodenal. Most of these came with the history that in earlier years the trouble had been diagnosed as gallstones. In one case, a year previous

to a duodeno-duodenostomy which gave perfect relief, an operation upon the gall-bladder had been negative. Six of these cases, however, when they came to operation, had, besides the gallstone-like colics, the pain, vomiting, gas, acidity, dilatation, and constipation (with few exceptions of above symptoms) characteristic of duodenal ulcer with motor insufficiency. The insufficiency would appear to come by spells, and seemed to be due in some cases, at least, to spasm only. A history of blood was given by three. Likewise in this group, gallstones entered largely into the diagnosis. Ulcer of the pyloric end of the stomach was not precluded in most of the cases. In one, where the complaint covered thirty years, the last three constant but not severe, where burning rather than pain came one to three hours after food, and constipation was severe, the diagnosis of ulcer was made. Gallstone history was entirely negative. Vomiting, gas, and acidity were absent or but little emphasized. The diagnosis rested on (*a*) burning in the stomach, worse two hours after food; (*b*) marked dilatation and emaciation; (*c*) constipation, and perhaps foremost of all (*d*) length of time (thirty years) the condition complained of, and (*e*) its appearance in decided spells. In this group the time of trouble ranged from five to thirty years.

Are there any characteristic symptoms of duodenal ulcer? If we try to differentiate between ulcer at or near the pylorus and duodenal ulcer, we meet barriers that are yet wellnigh insuperable. Often the two conditions are associated, and then the certainties of a diagnosis are quite beyond us. However, when the duodenum is involved the pain, gas, acidity, and vomiting are as a rule more intense than if only pyloric ulcer (gastric side) is present, and the type of pain is more apt to approach that of gallstones. From ulcer situated in other parts of the stomach, the differentiation usually presents fewer difficulties. In the latter condition pain and vomiting come sooner after taking food, and the food is returned much as it is taken. Acidity is not so great, and is often not noticed; gas, if present, is rarely so annoying a symptom, and blood is perhaps oftener found in the vomit.

It will be seen that cholelithiasis was the chief error into which

we fell in our diagnosis, and practically it is the only trouble worthy of consideration in making a differential test.

Pain in cholelithiasis is oftener sudden, severe, has a wide field of radiation, comes absolutely irregularly, is independent of and is not eased by food, nor so often traced to it. No stomach history is given between the short, precise spells; spasm of the diaphragm is nearly always observed, and vomiting and gas are present only during the attack, and the relief through vomiting and gas eructation is not as certain. The vomit is usually scanty, yellow, and bitter, and acidity is extremely rare.

In duodenal ulcer the pain comes in decided periods of attack, may be and often is sudden, has a very limited field of radiation, may be irregular as to time of separate attacks, but regular as to periods. It is quite dependent upon food, being early eased, and later pain and distress appear. The history of gas, vomiting, and acidity runs parallel to the periods of pain. No spasm of the diaphragm occurs except in some cases of perforation. The vomiting and belching are usually decided in quantity and quality and followed by relief.

Of course, stone in the common or cystic duct, or a decided infection of the gall-bladder, acute or chronic, has a definite period of attack; but jaundice, an enlarged gall-bladder, chills and fever with other symptoms, usually give little uneasiness in diagnosis. Acute infection of the gall-bladder and perforation of duodenal ulcer are often so nearly identical as to pain, palpation, and location, that gallstones is the commoner diagnosis in either case. A careful history will be the great weapon of defence —the only means of differentiation. Here let me say that the clinician who has the greatest skill in developing exact histories and has judgment to arrange, will be the one to make the most accurate diagnosis, and will usually find other methods quite unnecessary if not wholly superfluous.

The day of duodenal pathology has scarcely advanced to dawn. The diagnosis is indeed difficult, but treatment approaches solution. Fifteen years ago the internist and surgeon alike stood helpless beside the diseased appendix; ten years later both were

writing and talking intelligently, and diagnosis and operation were generally well made. To-day a large percentage of cases comes to the surgeon, the diagnosis of appendicitis made accurately by the patient himself. So, too, in gall-bladder surgery, during the last ten years much has been written and numberless operations reported, so that gallstone *per se* has been robbed of both its operative and diagnostic terrors, and the surgeon at large finds such operations to his credit. However, the surgeon who will face every gallstone diagnosis and be master of the occasion must be schooled in the surgery of the stomach, duodenum, and pancreas, or his record of failures will be most discouraging.

There will always remain a certain proportion of cases that will mislead the careful physician. Those gallstone cases where the stomach symptoms of gas, distress, sour belching, and dilatation predominate and pain is but little complained of (and that only of a dull character), will usually be diagnosed as ulcer; while the duodenal case, whose chief symptom is the sudden, sharp, intense pain of perforative peritonitis, and where, with no obstruction or hyperacidity, the other stomach symptoms are in abeyance, will fall to cholelithiasis. Such error in diagnosis does not militate against the clinician, as both conditions are purely surgical, and the differentiation in many cases must be made on the operating-table.

THE SURGICAL SIDE.

Duodenal ulcer has been considered a rare malady, and surgically has not received the attention its importance merits. Weir, in a masterly paper before the American Surgical Association in May, 1900, analyzed the cases reported in literature, and, with observations drawn from his own experience, placed the subject on a sound foundation. Interest has been still further quickened by a number of workers, notably Murphy and Brunner.

It has been stated that nearly all duodenal ulcers are secondary to gastric ulcers and that the two are usually combined in the one case. This has not been entirely borne out by our experience,

at least the gastric ulcer if present has not been of the same grade and character as the duodenal. It is of course possible that a round or fissured ulcer of the stomach might have existed without recognition from the exterior of the stomach.

Based on the same examination, in 9 out of our 46 cases of duodenal ulcers there was a separate distinct ulcer found upon the gastric wall. In 16 cases the pylorus was involved by a lateral extension of the duodenal ulcer, making 25 out of 46, or about 53.33 per cent. In 100 cases of chronic gastric and duodenal ulcer recently reported by Moynihan (*Annals of Surgery*, May, 1904), 22 per cent. involved the duodenum, in 9 the lesion was confined to the duodenum, and in 13 separate ulcers existed upon both gastric and duodenal walls. Up to two years ago 11 per cent. of the gastric and duodenal ulcers which came under our care involved the duodenum, 89 per cent. the stomach. During the past year and a half with more careful observation we find 27 per cent. duodenal alone or combined with gastric ulcer. This includes a numerous group of duodenal ulcers which extend up to and involve the pyloric ring.

We have seen a number of pyloric ulcers due to lateral extension and involvement of a gastric ulcer, and in several of these the duodenum was attacked on one margin. In others the gastric wall was involved in a duodenal ulcer, the classification of gastric or duodenal being based upon the extent of the involvement. In all of the cases of duodenal ulcer, with three exceptions, the ulcerated area was easily identified as a thick, opaque spot, puckered in appearance and usually covered by peritoneal adhesions, closely resembling the large irregular gastric ulcer of Robson, and likewise it has been more frequent in adult males. Seymour Taylor, in this variety of gastric ulcer, found 72 males to 28 females. In the series of 46 duodenal ulcers herein reported 33 were in males, 13 were in females. In but one of the acute perforating cases was the ulcer clean, clear cut, and set in normal tissues; in all the others the perforation was through a thickened area. In the chronic cases a few completely surrounded the duodenum, in others the outlines were irregular and of various

sizes and shapes, and in the smallest at least 1 cm. in diameter. Most of them involved a considerable extent of intestinal wall. The 3 cases without any appreciable thickening are of great interest. The one of acute perforation just referred to gave a history of four years' chronic trouble; no other ulcerations of either stomach or duodenum could be detected. In the second there was chronic hemorrhage with an acute exacerbation. The third case, in which gastroenterostomy was done, died six months later from another cause, and post-mortem did not disclose macroscopic evidence at site of previous thickening of any defect in the mucous membrane. This would seem to indicate that typical round ulcer of many years' standing may exist without involvement of the outer coats, and therefore give little or no external evidence of disease, just as happens in the stomach. It is probable, however, that most duodenal ulcers are of the cicatricial type, and in our series there has been a relatively greater tendency to perforate than in gastric ulcer. This is shown by the peritoneal adhesions which are found in almost every case, and by the frequency of what may be called chronic perforation, protected by a mass of adhesions to the liver, gall-bladder, or gastrohepatic omentum. These structures often form a plaster over the perforation and protect against extravasation of bowel contents. Such chronic perforations were found in 8 of the 46 cases. In but 2 cases did there appear to be more than one ulcer of the duodenum, and in one of these there was some question as to whether there were not some connection between. In 2 cases of supposed gall-bladder disease, which we had opened and drained on account of adhesions thought to be due to cholecystitis without stones, no relief followed and reoperation became necessary. At this time more careful investigation revealed duodenal ulcer.

In a previous paper (*Annals of Surgery*, July, 1903) the writer referred to 4 cases of periduodenitis of unknown origin operated upon for supposed gall-bladder disease, and in which the condition of the gall-bladder did not bear out the presumption. One of these cases has since been reoperated and duodenal ulcer found.

Considering the known errors and the possibilities springing from a predetermined gastroenterostomy and imperfect examination of an ulcer situated in the pyloric region, it must be evident that duodenal ulcer is a far more common condition than has been thought. The situation of the duodenum renders it especially liable to erosion from irritating gastric secretions which the thinness of its tunics enables it to resist but feebly. Its sheltered situation fortunately enables protective adhesion in many cases, while its limited capacity and freedom from obstruction beyond prevent tension. The normal condition of relatively sterile contents, especially in the class of cases under discussion, also is a favorable circumstance.

All the cases of duodenal ulcer occurred in the first two-and-one-half inches of the bowel, and entirely above the entrance of the common duct, and therefore in an accessible situation. These errors should be largely eliminated, and in all doubtful cases of gallstone disease and gastric ulcer in which duodenal ulcer is possible the first portion of the duodenum should be inspected. For this reason we now employ in all doubtful cases a longitudinal incision one inch to the right of the median line through the rectus muscle. This enables careful examination of the duodenum, gall-bladder, stomach, and pancreas. If more space is needed, Bevan's lateral curved prolongation of the incision at either the upper or lower end, or both, gives additional access to these organs. Longitudinal incisions through the body of the muscle close well, and are more reliable against hernia than when located in the median line.

The operative indications are few. The causation and continuation of duodenal ulcer depends on the irritating gastric secretions. These must be diverted by a gastroenterostomy. If acute perforation exists, suture of the opening and cleansing of the infected area in the peritoneal cavity, combined with gastroenterostomy if the patient's condition warrants it, best fulfils the indications. For convenience the 46 operated cases are divided into five groups. 1. Acute perforation. 2. Hemorrhage. 3. Chronic ulcer with gastric complications. 4. Chronic perforating

ulcer with gall-bladder and liver complications. 5. Chronic ulcer requiring operation for relief of pain and distress.

Group 1. Acute perforation, 4 cases, 2 deaths. Acute perforating ulcer was found four times; in each case it was a complication of a chronic condition with a history of four to twenty-one years' standing. In 3 there was some attempt at adhesion, the acute perforation evidently occurring at a site of a chronic protected perforation. In 2 of these cases there was a large sized opening found. In only 1 case already referred to was there a clean-cut perforation through what was otherwise normal bowel wall. In 2 cases suturing was easy, in 2 difficult and unsatisfactory, requiring gauze packing. One of these cases died from inanition from prolonged leakage, although a gastroenterostomy was done at the same time. In the other the gauze pack was left undisturbed eleven days and rectal feeding employed for five days. The leakage was but slight, and the fistula soon closed. In two patients the suturing held perfectly, but unfortunately one died from pneumonia on the tenth day. In this patient a gastroenterostomy had also been done. The conditions were unusually favorable for an operation, which was performed within two hours of the accident, and the gastroenterostomy was considered advisable, as it seemed certain that stenosis would follow, as it had existed previously. Superficially, this would seem to argue against gastroenterostomy in acute perforation, but in each case the post-mortem showed the gastroenterostomy to be perfect.

Group 2. Hemorrhage, 1 case, 1 death. There was a single case of prolonged and repeated hemorrhage in a chronic ulcer of three years' duration; during a two weeks' period of observation the stools showed constant evidence of blood. There was a single hæmatemesis. The ulcer was easily recognized as a little thickened patch of otherwise normal bowel wall, and was excised with pyloroplastic enlargement. The man was markedly anæmic and a poor subject for anything but a forced operation. Valuable time had been lost in attempting to build him up. Death from pneumonia occurred on the fifth day.

Group 3. Duodenal ulcer with gastric complications, 25 cases, one death. Chronic ulcer with stomach complications from interference with gastric drainage was the most frequent form met with, and gastroenterostomy was performed with successful issue in each instance, excepting one in which acute obstruction of the transverse colon followed anterior gastroenterostomy, with death on the sixth day. In this patient at post-mortem a long prolapsed transverse colon was found hanging over the jejunal loop as it would over a clothes-line. The symptoms were not acute until a few hours before death. Reoperation should have been done.

Group 4. Duodenal ulcer with gall-bladder and liver complications. Eight cases, one reoperation, no deaths. In this series gastroenterostomy was performed in 5 cases with successful outcome. In 4 cases plastic operation was resorted to with excision of the ulcer. In 3 a modified pyloroplasty, one after the Heineke-Mikulicz plan, with a poor result, a secondary gastroenterostomy being required within three months, the other two after the plan of Finney, and with success. In the third the duodenum, at a point two inches from the pylorus, was acutely flexed upon itself by adhesions to the liver, due to a closed adherent perforation. This made it possible to do a plastic operation upon the first portion of the duodenum without disturbing the adhesion, a duodeno-duodenostomy.

Group 5. Eight cases, no deaths. In this small series only were there symptoms calling for operation which did not involve the stomach or gall-bladder, and still further emphasizes the fact that it is usually the complication which hastens operation. In practically all of these cases adhesions marked previous attacks of regional peritonitis. Gastroenterostomy was performed in each with good results.

To recapitulate, there were 47 operations in 46 cases. Of these 5 were for acute conditions developing upon chronic ulcer, with three deaths. Forty-two operations for chronic conditions gave one death. At the present time posterior gastroenterostomy would appear to be the operation of choice in the chronic cases;

but the last word has not yet been said. The time elapsed since operation in the majority of the cases herein reported suggests the possibility of further sequelæ, particularly in those cases in which there is no obstruction and in which experience has taught us that at least partial closure of the gastroenterostomy opening may take place. It is pretty certain that even with a large gastroenterostomy the food will pass out by preference through an unobstructed pylorus by muscular action, the apparent gravity advantage of a low-point gastroenterostomy being equalized by intra-abdominal tension.

DISCUSSION.

Dr. E. Wyllys Andrews, of Chicago.

The surgical importance of perforating ulcer of the duodenum was recognized long ago, but I think we must revise our ideas of the pathology of ulcer in general of the non-perforating type from a surgical standpoint.

It has been my fortune to see in the last year or two several cases in which a marked hyperplasia, patches of exudate, with thickening of the wall of the duodenum, ulceration of the first inch and a half of the duodenum connected with a similar condition of the pylorus have produced such a degree of massive thickening that, clinically, at the time of operation, it was indistinguishable from carcinoma. In one such case the operation, which was a McGraw elastic ligature gastroenterostomy, left me in a dissatisfied state of mind, as I feared I should have done a more radical extirpation, and yet in that particular case it was my fortune to do a second operation for obstruction a year later, or after the first operation, and I found, very much to my surprise, absolute disappearance of the thickened massive wall which had formed in the first place and which simulated carcinoma. This is exactly what Mayo himself called attention to something over a year ago, namely, when the obstruction is relieved, when the flow is permitted from some other point, the inflammation, or ulceration, at any rate, the hyperplasia, disappears at the point of irritation, and, secondary to that again, when obstruction has been relieved by drainage below, if the pylorus is open, the drainage below ceases to act, and again the opening becomes closed, so that we have to do sometimes a second gastroenterostomy.

In the case I spoke of I even had a large gland which I was able to palpate distinctly, so that I could see plainly the condition was possibly malignant, possibly inflammatory. The opportunity for examination here showed absolutely that there was no malignancy, yet to the eye the conditions were such as to make it impossible to determine this. Keen, in a paper some three or four years ago, called our attention to patches of exudate that existed on the stomach wall opposite or corresponding to the site around the ulcer within the lumen of the cavity. This condition in the pylorus, and descending so as to involve an inch and a half of the upper portion of the duodenum, produces this carcinomatous-like thickening which has not been recognized very much, and to which our attention has been called for the first time possibly in this paper.

Dr. John B. Murphy, of Chicago.

The great lesson to be learned from Dr. Mayo's paper is not the magnificent low mortality which he attained, but the practical lesson which it teaches to the average surgeon of the frequency of occurrence of duodenal ulcer, and, second, that it is not recognized by the general practitioner, the specialist, and, I am sorry to say, by the practising surgeon. The next great lesson is that in many cases it is difficult or impossible to differentiate it from gastric ulcer or gall-bladder disease, whether the latter be of infective or stone origin.

It is for these important points that we are so much indebted to Dr. Mayo for this able paper. Weir, in his original work, outlined definite trains of symptoms as indicative of this disease, and in these he was supported by many subsequent observers; but the idea that in duodenal ulcer alone the pain occurred in from two and a half to three hours after the ingestion of a meal is exploded by many observations. Where the ulcer is situated in the stomach close to the pylorus, the pain occurs at about the same period of time after the taking of food as it does in duodenal ulcer; the pain is due to the expansion and contraction of the pylorus in allowing the food to escape when gastric digestion is complete.

It is evident from the points brought out in this paper that the exact differential diagnosis between lesions of the gall-bladder, pylorus, and duodenum cannot be made, but they are all surgical diseases, they all demand surgical interference, and the differential diagnosis can and should be made after the abdomen is opened. With this principle as a basis many more surgical procedures in the right hypochondrium will be undertaken, and the success of surgical interference in that neighborhood will be more uniform and lasting if the differential diagnosis is to depend on close scrutiny after the organs are exposed in operating.

Dr. Alexander Hugh Ferguson, of Chicago.

I rise for two reasons: (1) To compliment Dr. Mayo on his splendid work; (2) to ask three questions:

1. I would like to ask Dr. Mayo if he has outlined for himself the class of cases in which he would do gastroenterostomy (posterior).

2. The class of cases in which he would do gastroduodenostomy (Finney's operation).

3. If he has met any cases in which he would resort to pylorectomy.

I have had one case in which I did a pylorectomy, removed the end of the pylorus and a portion of the duodenum, with an excellent result.

Dr. Mayo. Just a word or two in regard to ulcer of the stomach and duodenum. If we take our experience for the last year and a half

with the large, thick ulcer of the stomach, the so-called "Robson ulcer," and the same class of ulcer in the duodenum, we have found them to be of nearly equal frequency in each organ. This, much to our surprise, as we had supposed the gastric ulcer was far more frequent. There is no question as to the diagnosis in these cases, because we can feel and see them, and they involve a considerable extent of the duodenal and stomach wall.

Another thing is that in at least one-half of these cases of duodenal ulcers the patients were operated on under mistaken diagnosis. In many the operation was started for gall-bladder disease, others for chronic gastric ulcer. There are two distinct classes of cases of gastric ulcer upon which we are called upon to operate. First, the ulcers diagnosed medically and sent to us for operation, and in whom we do not find at the time of the operation what we expected to find—that is, an ulcer which could easily be recognized. Here we have a surgical operation which is projected for the relief of a medical condition, the patient having had all of the symptoms of ulcer, but in which, after a superficial examination of the stomach, one does not find evidence of it except possibly a little thickening. On opening the stomach in some such cases I have searched the gastric interior carefully with the expectation of finding the seat of the ulcer, and usually succeeded, but have not always been able to detect a round or fissured ulcer which involves the mucous coat only, although bleeding had continued for days, or, in some cases, off and on, for weeks before operation. For want of a better name I have called these cases "medical ulcer"—that is, an ulcer which is not easily located from the outside of the stomach. We must operate sometimes because of the severe symptoms, and do not at the time of the operation thoroughly and carefully explore, for good surgical reasons, hoping that after drainage the ulcer may heal. The excess of gastric ulcers over duodenal ulcers lies largely in the group of medical ulcers. The easily detected thick ulcers involving all the coats of the stomach we have called "surgical ulcers," and, as I have said before, nearly equally in the stomach and duodenum and often in both.

In regard to the question of Dr. Ferguson, I do not know that we have ever tried to excise a duodenal ulcer except in connection with Finney's operation. They are irregular and thick; they lead to large vessels, and are close to the common duct, and it is difficult to get a good suture line. The best thing to do, I believe, from our own experience in these cases, is to make a gastroenterostomy, which will afford, at least, temporary relief, but in the non-obstructed cases it is probable that food will after a time continue to pass down over the duodenal surface and that the gastroenterostomy opening may contract from disuse. Possibly some of these patients may return for a secondary operation, although we have not as yet had such a case.

COMPLETE REMOVAL OF THE SHAFT OF THE TIBIA FOR OSTEOMYELITIS, WITH RESTORATION OF THE BONE.

By GEORGE BEN JOHNSTON, M.D.,
RICHMOND, VA.

The following six cases of removal of the entire shaft of the tibia or fibula are presented because the results of operative treatment were so satisfactory, restoring otherwise hopelessly damaged limbs to usefulness.

Osteomyelitis is a disease which occasions much suffering, produces many deformities, and causes many deaths. It is therefore of sufficient importance to warrant a word of warning to physicians and ask on their part early recognition of it and prompt reference to a surgeon.

It is not meant to review the subject of osteomyelitis to this body of surgeons, but merely to present these cases and briefly make a few suggestions to such physicians as may see this report. Some forms of osteomyelitis are so obscure as to be difficult of recognition, and great damage is often done before a correct diagnosis is made and surgical treatment practised. The milder forms are mistaken for "growing pains," malarial fever, typhoid fever, and rheumatism. The more violent and active, for erysipelas.

When it is remembered how destructive this malady is and how dangerous to limb and life, the importance of early diagnosis and prompt reference to a surgeon are manifest.

The infection is not always of the same degree of virulence. The milder forms may pursue a more or less chronic course, but

the acuter forms are so violent as often to cause prompt death or at least to destroy a bone, and this in a few hours.

The diagnosis is commonly not difficult. It generally attacks young, growing children, usually males. The bones oftenest involved are the exposed ones, notably the tibia. It is almost invariably traced to an injury, which is sometimes too trivial to be noticed at the time it is inflicted.

The constitutional manifestations vary all the way from malaise, general indisposition, and slight fever to a profound, overwhelming, and even fatal septicæmia.

Where infection is slight the course of the trouble is mild and more or less obscure. Where the infection is virulent the symptoms are violent.

The age and sex of the patient, the history of an injury, the character of the pain, generally worse by night, a tender spot in the course of a bone, with redness and swelling, if superficial, suggest osteomyelitis.

Treatment must be prompt. Free drainage is imperative. If the disease involves only the superficial aspect of the bone, a free incision with proper disinfection and maintained drainage may be all that is required. Should the infection be in the medullary cavity or be otherwise deep seated, it must be found and proper drainage established. If the lesion has advanced to complete destruction of the bone, the treatment must be sufficiently radical to encompass the removal of all dead bone. This will occur in the more violent forms unless treatment is resorted to early enough to destroy the infection and thus prevent complete destruction. Where the major portion of a bone's shaft is destroyed, or is so involved as to require removal, this must be done. Where the entire shaft is removed, regeneration can only be of periosteal origin, and therefore the periosteum must be carefully preserved.

After free incision and removal of all diseased or dead bone, the wound should be most carefully antisepticized and maintained in this condition. Throughout immobilization is important and gives much comfort. For this purpose an ordinary fracture-box is the best appliance.

The dressings are to be as infrequent as is consistent with asepsis and always gently done. As new bone tissue begins to form, the parts may be shaped by the proper adjustment of adhesive strips and bandages, so that deformity may be lessened. When cicatrization is complete, a light plaster-of-Paris cast is applied for the purpose of affording protection to the young and tender bone. The body weight should not be borne on the limb until the new bone has attained sufficient rigidity to support it safely. The general health will always require attention. Tonics, ample food, and fresh air will expedite recovery.

Where a disk of bone can be left covering the epiphyseal line, no deformity in the length of the bone will result. If the epiphyseal junction is destroyed, there will necessarily occur shortening. This may mean aggravated deformity, but no great impairment of limb function.

When one of a pair of companion bones is destroyed, the other invariably takes on compensatory hypertrophy.

Case I.—1888. T. R., a boy, aged seven years. Had an injury to the right tibia, falling against a curbstone. Seven days after a painful swelling appeared over the lower third of the left shin. The family treated him for rheumatism, and not until the symptoms became alarming was a physician called. The family physician treated him with poultices, quinine, and opium for three weeks. I saw him in October, 1888, when the disease had existed over six weeks. He was much run down in health and very septic. The swelling was immediately opened by a free incision. It was discovered that the tibia was dead and the periosteum detached from an inch above the junction of the lower end of the shaft with the epiphysis to a point two inches below the upper epiphyseal attachment. The dead portion of bone was removed with a thin disk of healthy bone attached. This was accomplished by stripping away the periosteum where it was attached in small islands to the diseased portion of the bone, and separating it from the healthy bone a short distance above and below the diseased portion, and then with a chisel dividing the shaft in healthy bone and lifting the shaft thus separated out of its bed. The periosteum

was intact throughout. An antiseptic dressing was applied after disinfecting the enormous wound thus made, and the dressed leg was placed in an ordinary fracture-box.

Almost immediately the child's general condition improved, all pain subsiding and fever disappearing, and nutrition was resumed.

The wound granulated rapidly, and in the course of three weeks a needle could be made to indicate the presence of bone tissue in the granulations. Three months were required for the new bone to form and the wound to cicatrize completely. When this was accomplished the leg was encased in a plaster-of-Paris splint and the boy allowed to go on crutches. He was not permitted to use the limb for a year, at the end of which time he walked freely without limp or pain. The new tibia was somewhat ill-shapen, being flattened from before backward, but had sufficient strength to meet all requirements.

I was able to keep track of this little fellow for six years after the removal of the shaft of his tibia. During this time he seemed perfectly well and suffered no inconvenience from the loss of his bone, the function of the leg being perfect.

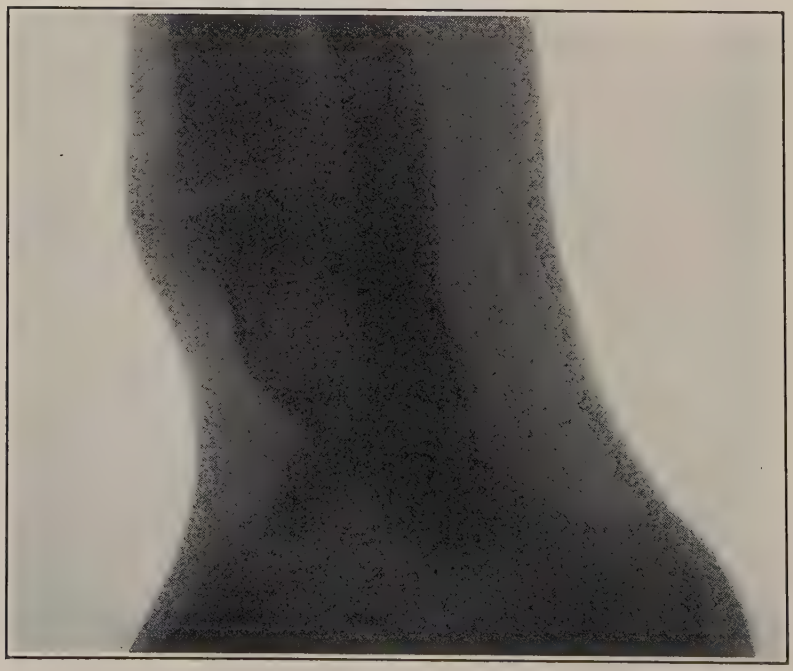
I regret I have no photographs of this case.

Case II.—1894. T. S., a boy, aged eight years, while playing ball was injured on the right shin, the trouble being so trifling at the moment as to receive no attention either from the boy or his parents. A week later he began to complain of a deep-seated pain in the shin, aggravated at night; had high fever, loss of appetite, and rapid wasting of flesh. When these symptoms had progressed a few days I was consulted.

A diagnosis of osteomyelitis was made and surgical treatment applied. Exposure of the tibia displayed a deeply congested and thickened periosteum. The medullary cavity was trephined and a considerable quantity of fetid pus evacuated. The symptoms were not promptly or materially ameliorated by this treatment. The disease rapidly spread, so that in ten days after the trephining of the bone a second operation was demanded and a longer incision made, extending two inches below the knee and well down

Case II

Case II.



to the ankle. It was found that about four-fifths of the shaft of the tibia were completely dead, the periosteum being separated almost entirely from this portion of the bone. The dead portion of the bone was removed, comprising about four-fifths of the shaft, the division being made well out into healthy bone. The after-treatment was the same as applied in the former case, including immobilization of the leg in a fracture-box.

This youth made a rapid recovery, and the result in his case is absolutely perfect, a skiagraph showing practically no deformity in the tibia. He has grown almost to manhood, is leading an active life, and has positively no lameness, the two limbs being the same length and apparently of the same strength.

Case III.—R. M., a boy, aged thirteen years, in December, 1893, received a blow on the left ankle too insignificant to attract attention. Three days after this injury a painful, red swelling appeared just above the joint on the tibial aspect of the leg. This at first was thought to be rheumatism. It extended up the leg so rapidly, and the redness and swelling increased so that it was later thought to be erysipelas. I saw him five days after the appearance of the swelling. His pain was excruciating. He was overwhelmed with sepsis, and his condition appeared most precarious. The diagnosis of acute infectious osteomyelitis was made and no time lost in opening the pus cavity. An incision was made the whole length of the tibia and an enormous amount of stinking pus poured out. Everywhere the periosteum was detached, and likewise the epiphyseal lines were separated, so that the entire shaft of the bone was found literally floating in a pus sac. The bone was lifted out without the application of a particle of force or the stroke of a knife to free a single attachment.

After proper preparation of the wound it was packed with iodoform gauze and outside dressings applied. The leg was put into an ordinary fracture-box and immobilized by packing about it snugly a quantity of wheat bran. For many days the issue was doubtful, but finally improvement began and progressed steadily. The leg was kept in a fracture-box until the wound had healed and new bone formed, after which time a light plaster-of-Paris dressing was applied and the boy allowed to go on crutches. At

the end of eight months the new bone was deemed strong enough to support the weight of the body. On account of the destruction of the epiphyseal lines there was considerable deformity in this case, the tibia not growing in length. Nevertheless the limb is perfect in function, and when a thick-soled shoe is worn no lameness is apparent. A most interesting feature of the skiagraph is the exhibition of a false joint in the new tibia about three inches above the ankle-joint.

Case IV.—A boy aged twelve years was seized with pain in his shin. This was soon followed by redness and swelling. The trouble was at first ascribed to rheumatism. Later Dr. Warinner was called and pronounced it osteomyelitis. I first examined him at the Old Dominion Hospital. His leg was enormously swollen and very red, and fluctuation was present throughout the entire extent of the tibia. The boy being profoundly septic, and his condition being alarming, operation was immediately performed.

An incision was made extending the whole length of the tibia. When the bone was exposed it was discovered to be entirely denuded of its periosteum, and, like Case III., was lying loose in a pus sac. It was simply lifted out without any resistance by adherent membranes or epiphyses. As in the other cases, the wound was cleansed and dressed antiseptically and the leg placed in a fracture-box.

Prompt relief from constitutional symptoms supervened and the boy's general health rapidly improved. He made excellent progress and was able leave at the end of eight weeks with a light plaster-of-Paris dressing. He was allowed to go on crutches, with the leg suspended, at the end of ten weeks. In six months the bone, which was much distorted, was able to bear the weight of his body.

It will be seen, by reference to the skiagraph of this case, that, unlike Case II., formation of the bone was incomplete, there being a hiatus of fibrous tissue about the middle of the bone. The leg is sufficiently strong, however, to bear the weight of the body without the aid even of a cane. In consequence of the removal of the entire shaft and the destruction of the epiphyseal junction

Anterior view of left leg, showing false articulation seven years after exsection of fibia.

Case IV.

Case V.

Case VI.

Photograph eight years after operation.

there is, of course, much shortening of the new tibia, but by means of a high shoe there is but little lameness. The function of the limb is excellent.

Case V.—L. J., a boy, aged eleven years, referred by Dr. H. H. Henry, was admitted to the Old Dominion Hospital January 5, 1903. At the time of his admission his condition was deplorable. He had an acute osteomyelitis of the left tibia and a very acute inflammation in the right hip-joint. He was so profoundly septic that his life was despaired of. His symptoms had developed with great rapidity and violence, following a slight hurt. The whole of the left leg was very red and enormously swollen. Fluctuation was present over the whole tibial region.

An incision was made the entire length of the shin-bone, which was found suspended in a pus sac, and, like Cases III. and IV., the bone was free. No force was required to extract it, it being literally lifted out of its bed. This case was treated like the others, and at the same time treatment was applied to the diseased hip-joint on the opposite side. The issue in this case appeared doubtful for many days, on account of the profound sepsis present, but finally the little fellow began to improve, and, after a long and tedious illness, he recovered, with an excellent new tibia in the left leg and a good result from treatment of hip-joint disease of the other side. The after-treatment of this case was the same as in the previous cases, including the fracture-box. After the new bone had formed and the wound completely cicatrized, a plaster-of-Paris cast was applied for the protection of the new bone and to give rigidity to the limb. At the end of ten weeks the boy was able to go on crutches, and later, by the aid of a high-soled shoe, could walk without great lameness, and what lameness was present arose from the injury to the right hip.

I regret not being able to present a skiagraph of this case, but an excellent photograph of the injured leg is shown.

This boy lived comfortably and was able to get about in excellent shape for several months. In the spring of 1903, he was seized with some acute abdominal trouble, supposedly an abscess of the mesentery, from which he died.

Case VI.—H. T., a sturdy boy, aged five years, was referred by his uncle, Dr. Henry Turnbull, of Lawrenceville. This little fellow came in one evening from play and complained to his mother of pain in his leg, over the fibula, saying he wanted to go to sleep. His mother examined his leg and found the ankle a little red and somewhat swollen. The next morning the leg was very much swollen, and there was high fever. He suffered greatly and was not able to walk, and the limb remained in this swollen condition for five or six weeks, when a "soft place" was noticed on the ankle, and the attending physician opened this and kept it open. In two weeks small particles of bone worked out of the wound. At this juncture I saw him.

I discovered that the major portion of the shaft of the fibula was necrotic. Incision over the bone was made, extending upward from the external malleolus to within three inches of the head of the fibula. It was manifest that no part of the bone could be saved except the lower malleolus and a small portion of the upper extremity.

With a Gigli saw the bone was divided through its healthy parts and the diseased portion removed. With the free drainage thus accomplished and the removal of the necrotic bone, septic symptoms quickly subsided. The after-treatment was precisely as in the others, viz., antiseptic dressings and immobilization in a fracture-box. This little fellow did remarkably well, and in six weeks was able to leave the hospital with his leg in a plaster-of-Paris dressing. The bone rapidly reformed, and in six months the child was entirely restored to health, with the limb unimpaired. Eight years after operation the accompanying photograph (Fig. 6) of the leg and a skiagraph of the bone were made. It will be seen, from the skiagraph, that the bone is perfect. The leg is absolutely perfect in function, and the youth, now thirteen, is as sturdy and healthy as any boy of his age.

In considering these cases I am impressed with a number of facts well worth emphasizing:

1. All my cases were in males.
2. In every instance they were in growing children.
3. The trouble was always traceable to a trivial injury.

4. Exposed bones involved: the tibia in five instances, the fibula in one.

5. There was remarkable variation in the degree of virulence of infection.

6. The extent of destruction was dependent upon the character of the infection.

7. There were profound constitutional symptoms where the infection was virulent.

8. The condition was often mistaken for "growing pains," rheumatism, or erysipelas.

9. Regeneration in my cases was entirely of periosteal origin, and was rapid and complete.

10. Deformity resulted only in such cases as had suffered destruction of the epiphyseal line.

11. There is no deformity where a disk of bone is left between the shaft and the epiphysis.

12. Invariably the companion bone takes on compensatory hypertrophy.

13. Time to operate:

(*a*) In acute cases (imperative) immediately.

(*b*) In subacute or chronic cases (elective) when new bone tissue has begun to appear.

14. Operation:

(*a*) Free incision and complete removal of *all* diseased bone.

(*b*) Spare all periosteum possible.

(*c*) Avoid curette, or use cautiously.

(*d*) Purify the wound by the strictest antiseptic methods.

After-treatment:

(*a*) Maintain aseptic conditions.

(*b*) Avoid too frequent and rough dressings.

(*c*) Treat as a fracture, by immobilization in a fracture-box.

(*d*) Carefully shape the parts, as bone tissue develops, by bandages or adhesive straps.

(*e*) Protect the young bone by means of plaster-of-Paris.

(*f*) Abstain from use of the limb until the new bone is capable of sustaining the weight of the body.

(*g*) Look after general health.

DISCUSSION.

Dr. De Forest Willard, of Philadelphia.

Dr. Johnston's description of these cases corresponds so accurately with their usual history that it is exceedingly instructive. Not only the family physicians, but it is greatly to be regretted that surgeons go on treating these cases for rheumatism when there is absolutely not one sign of that disease. They are from the beginning cases of acute suppurative osteomyelitis. Then come the septic symptoms. The physician treats these patients for typhoid fever and other conditions until they drift into the hands of the surgeon in the state in which Dr. Johnston reports, with bones destroyed, and the majority of them crippled for life. As I have said, they are treated in the beginning as cases of rheumatism. When will our profession be rid of the practice of calling every pain "rheumatic?"—that term that is but the abominable cloak of ignorance, carelessness, and cowardice. These cases from their incipiency are virulent in type, and the only time for successful treatment is within forty-eight hours from the onset; the quicker we get inside the bone-marrow the better. If cases of appendicitis should be operated upon early, surely it is doubly important that these cases of acute osteomyelitis should be diagnosed and operated at once.

Dr. A. J. Ochsner, of Chicago.

The points made by Dr. Willard are pertinent and correct. There is, however, another fact which is not very generally known, and which, I believe, is not recognized by many surgeons. It is this: In a large portion of the cases in which the shaft of the bone is entirely loose, when the periosteum is incised, if this bone is left in place, there will be a regeneration of a considerable portion of apparently dead bone. In other words, if we take such cases as Dr. Johnston has described, make an incision which extends from one end of the bone to the other, split the entire periosteum, make it necessary for the flow of lymph to be away from the tissues, leave the diseased bone there as a bone-graft, I have found in a considerable number of cases that there will be a regeneration of a large portion of this bone. In one case I had of loose metatarsal bone which seemed entirely destroyed at the time the incision was made, but which regenerated completely, the bone has remained now for four years without the exfoliation of any part of it, notwithstanding the fact that at the time the incision was made the bone was loose at the epiphyseal ends. In these cases, then, instead of removing the bone, an operation which I have done a number of times with results

similar to those obtained by Dr. Johnston, the proper thing is to treat it exactly as these cases have been treated, with the exception of removing the bone. In other words, make an incision quite as free as is necessary for the removal of the bone; treat the case as these were treated, leave the bone in place as a splint for the formation of a properly shaped involucrum in cases in which there is a destructive process and for the purpose of giving the bone an opportunity to regenerate.

Dr. John Collins Warren, of Boston.

I think Dr. Johnston is to be commended for his paper, because it treats of a subject a little out of the usual bounds of topics we have been discussing of late years, yet one extremely important to the profession, and I think his article deserves the seal of approval of this Association. It is a subject that should be thoroughly discussed, and a message given to the profession to realize the importance of this septic process, so that these cases of acute osteomyelitis may be sent to the surgeon early and treated properly.

As to treatment, the great point is to prevent the spread of sepsis. This may be accomplished by trephining the bone and by proper disinfection, a comparatively moderate operation, or it may be necessary in certain cases, as Dr. Johnston has shown, to do quite an heroic operation.

Dr. P. S. Conner, of Cincinnati, Ohio.

There is one point which I think it is worth while to consider, and that is in some of these cases the disease originates comparatively superficially. These cases are uniformly mistaken for erysipelas. The redness of the overlying skin, as a rule having almost no exception, is taken as an indication of the existence of the disease. Then, we have a condition simulating typhoid fever after the disease has existed for a considerable length of time, or rheumatism, if you please, for a while, then typhoid fever, when the condition does not subside.

There is no question in my mind but that early boring of the lower end of the tibia, because it is this part of the body that is most ordinarily affected, will put a stop to the trouble. A moderate incision will not infrequently end the trouble if boring does not. Splitting, as Dr. Ochsner has said, of the skin covering the shaft of the tibia may be all that is required. I have seen the shaft of the bone, after having been entirely separated from the overlying periosteum, reattach itself and become a firm part of the skeleton of the body. This condition, if allowed to go on for five or six weeks, requires nothing short of removal to afford relief. I remember very well a case that came under my care many years ago (the specimen of which is in the Army Medical Museum)

in which the reformation of bone took place from periosteum, which left a spoke five or seven inches in length running down the leg. We do not expect those things now. Rheumatism is not the only condition to be looked for; but rheumatism, erysipelas, and typhoid fever are the three conditions, and the seat of trouble nineteen times out of every twenty is largely just above the ankle-joint.

Dr. S. H. Weeks, of Portland, Maine.

While many of these cases commence as a periostitis, requiring a simple incision down upon the bone, there are many others which begin as an acute osteomyelitis commencing in the medullary canal, and I believe under these circumstances (and these circumstances exist in the majority of cases) when an incision is made down to the bone there should be an opening made into the bone or medullary canal and that canal drained.

ON PAPILLARY CYSTS AND PAPILLARY TUMORS OF THE OVARIES IN CONSIDERATION WITH PROGNOSIS AND TREATMENT.

By PROFESSOR S. POZZI,
PARIS.

Mr. President and Fellows of the Association:

When your Secretary, Dr. Allen, wrote to me, asking if I would be present as one of the representatives of French surgery at your meeting in St. Louis, I accepted without hesitation, as it would afford me not only the opportunity of again visiting this country, but of meeting the friends with whom I became acquainted eleven years ago on my first visit to the United States, and of acquiring others among the eminent men whom I have the pleasure of seeing before me to-day.

With the regrets of my colleagues, Prof. Terrier and Dr. Tuffier, who were unable to be present, I bring to your Association the good wishes from her sisters in science, the *Académie de médecine de Paris*, of which I am a Fellow; from the *Société de Chirurgie*, which I presided over once, and from the *Congrès français de Chirurgie*, of which I am President this year. I dare say that I bring, also, the expression of the sympathy and tender brotherhood between the French and the great North American Republics.

Cysts and papillary tumors of the ovary form but one clinical and anatomico-pathological group. Many of the papillary tumors are more or less large cysts which have ruptured. Moreover, the histological structures of these tumors is the same, and the

presence of a limiting cavity in one case and its absence in the other is but a temporary and accessory morphological difference. This has some importance as long as the papillary growings are wholly internal; but this difference completely disappears when, farther on, the outside becomes covered with papillary growths.

Two principal features distinguish these tumors: 1. Ascites, often considerable, in connection with vegetations of the surface. 2. Eventually the presence of disseminated growths over the parietal and visceral peritoneum, the omentum being sometimes infiltrated.

A clinically confirmed ascites and disseminated peritoneal vegetations, noticed under cœliotomy, have often led physicians and surgeons to consider these tumors as malignant in every case; that is to say, as if lymphatic invasion and generalization were fatal.

I propose pointing out that the prognosis has often been too severe. All these tumors have a malignant appearance to the naked eye, and it can easily be understood that many operators after opening the abdomen have closed it again after observing cauliflower growths on both sides of the uterus and disseminated vegetations all over the pelvic floor, with eventually thickening of the omentum. However, in such cases cœliotomy should not be reduced to merely an exploratory incision. A complete removal of these tumors can generally be made, and even an incomplete operation can be followed with recovery for a long period, if not permanently.

In order to be concise and clear, we will state at first the general propositions which will be supported by further developments, and present the conclusions of our paper before coming to the details.

Proposition 1. *Papillary tumors of the ovary (cystic or solid) must not be considered as always malignant. Some of these tumors never undergo malignant degeneration, and do not recur after removal; some relapse after a long period, but locally without metastases.*

Proposition 2. A careful distinction must be made between carcinomatous generalization (which takes place through lymphatics and bloodvessels) and simple grafts which result from contact or from growing on the peritoneum of detached papillary vegetations of the ovary. This process is benign, and can be compared to the grafting of papillomas and warts of the skin.

Authors are far from agreeing with each other as to the first proposition with regard to the benignity of papillomatous cysts. An account of the different opinions suggested on the subject can be found in E. Troscher's paper.[1] It would be too long to state them all here. Fourteen years ago I wrote the following lines in the first edition of my *Treatise on Gynecology:* "One point that is still obscure is the question of benignity or malignancy of papillomata of the ovary. It seems that the extreme instability of histological structure of these growths, the facility with which the cells undergo heterotypic changes, place these cysts, as may be said, in a perpetual state of *malignant imminence.*" Nevertheless, a great number of cases operated upon make a complete recovery, at least for many years.

A number of satisfactory recoveries obtained in cases which seemed hopeless can be found in a thesis by one of my pupils.[2] I have been obliged in some of these cases to remove secondary papillary grafts from the parietal peritoneum, from the broad ligaments, from the intestinal ducts, and even from behind the liver and the spleen. I have also removed by excision secondary growths from the omentum and mesentery.[3] Such patients have kept well for years (from five to ten years); one of them who presented the longest survival was a woman I operated upon for the first time in September, 1878. I removed a large papilloma of both ovaries, with great ascites.[4] The patient was then twenty-five years of

[1] E. Troscher. Beitrag 2 klinischen Digität der papillären ovarialgeschwülste. Arbeit Privat Frauenklinik. Mackenrodt, Heft 3, p. 21.

[2] W. Cazenave. Les tumeurs papillaires de l'ovaire avec métastase péritoneale, Paris, 1895.

[3] W. Cazenave. Loc. cit., abs. vi. p. 48.

[4] Bulletins et mém. de la Société de chirurgie, 1878, tome iv. p. 822.

age; recovery was complete for not less than twenty years (up to the middle of 1898), when ascites again appeared, the abdomen enlarged considerably, with œdema of both legs under the effect of compression. A second operation was performed on December 14, 1899. The recurrent tumor being quite fixed to the pelvic floor and the patient being in a very bad condition, I did not attempt to remove it, and only made drainage. The patient made a rapid but temporary recovery. Ascites disappeared, so did the œdema of the legs, and her health was again satisfactory for about one year. She died on May 4, 1901.

I am not aware of any other example of relapse after such a long recovery (twenty years). It could be pointed out that if this patient had died two years sooner she could have been quoted as an example of definite cure (in fact, she was so mentioned in the second edition of my *Treatise on Gynecology*, 1897).

In my second proposition I have urged the difference between true metastases, which is an undeniable proof of malignancy, and the grafts resulting from simple implantation of papillary vegetations on the peritoneum. Freund[1] noted long ago this distinction, which has since been confirmed by a number of authors.[2]

This principle has been too often disregarded, and the presence of disseminated growths has deterred many operators from completing their operation. Other surgeons who have removed the principal tumor have noticed that even after these incomplete operations patients have recovered, and ascites did not return.

During an iterative cœliotomy, I have been able to ascertain that papillary growths noticed on the intestines in the first operation had vanished. Liebreich in his inaugural dissertation, 1897, quotes a similar case of Bumm.

Proposition 3. *Some of these tumors undergo a malignant degeneration which is for some time limited, but can later extend all over the mass, and at last brings on a real generalization with can-*

[1] Ueber die Behandlung bösartiger Eierstockgeschwülste, 1889.

[2] Bland Sutton, Pfannenstiel, Pozzi, Cazenave, loc. cit.

cerous metastases. Before this last period, and at the outset of the malignant transformation, it is impossible to discern it with the naked eye, and microscopic investigations are needed. The prognosis is always uncertain in operations of this kind before a thorough pathological examination. Even this examination can lead to misinterpretation if it has not been carried all over the tumor, for the degeneration can be limited to a very small part of the growth.

In some cases there can be no doubt about malignant degeneration even to the naked eye. Hard, lardaceous masses, extensive adhesions, and large bloodvessels give to these tumors special features. In such cases extirpation seems so dangerous that some operators resort to an exploratory cœliotomy. When the tumor has been removed a rapid recurrence takes place, and, of course, microscopic examination will prove that the tumor is undergoing malignant process.

But close to these characteristic cases there are some others in which no evidence will be given to the operator that the tumor is already under malignant evolution. This seems to be an ordinary papillary tumor, but by subsequent histological examination of several parts a small part is found to be malignant. Such a verification belongs to the pathologist only. It is of little interest to the operator, because it comes too late; but it will at least allow him to be more guarded in his prognosis.

It seems probable that in all the cases where papillary tumors have rapidly relapsed with carcinomatous generalization there was already some malignant growth, but this point was so limited that it escaped notice. Cullen[1] has found that sarcomatous nodules may exist in a small point, on a single cavity of a multilocular cyst.

My associate pathologist, Mr. Bender, has been able to discover small cancerous masses scattered in apparent benignant papilloma. This phenomenon would not have been recognized by a less acute observer.

[1] Multilocular Adenoma-papilloma Cystoma of the Ovary. American Journal of Obstetrics, 1896, No. 3, vol. xxxiv.

In these figures, drawn under his direction, can be seen the structure of a simple papillary growth of the ovary (Fig. 1) and of the epitheliomatous degeneration of the same neoplasm (Fig. 2).

The practical consequences which result from the preceding consideration are these:

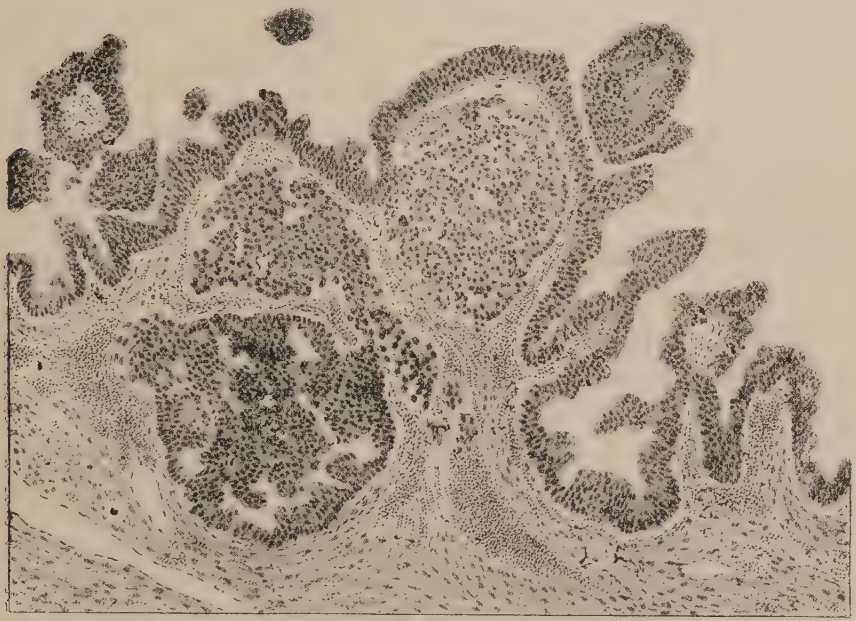
Proposition 4. When positive symptoms of malignancy (cancerous cachexia or visceral metastases) are missing, one must act toward these tumors as if they were benign, and remove as large a portion as possible of the neoplasm. The disseminated growths or even small parts of the papillary tumor detached and lost in the peritoneal cavity may disappear; in other cases they will be the origin of local recurrence. But these relapses can be successfully treated by secondary operations.

FIG. 1.

I have already spoken of the resorption noticed in the course of new operations (after a previous laparotomy) of the papillary growths spread over the peritoneum around a large cauliflower tumor of the ovaries. This observation must lead the surgeon to believe the sowing of these surrounding growths as the sign of generalization and urge him to remove the principal nodule, with

the hope of seeing the secondary vegetations resorbed. In several of the cases which came under my observation I proceeded in that way, and have seen patients recover without any recurrent ascites. Several cases of this kind might be mentioned, but I will only relate the most striking one, which will show how useful it is to express our conclusions, since they are still disregarded by men of prominence in the profession.

FIG. 2.



Last November I was visited by a French lady, a resident of the United States. She was introduced to me by an eminent gynecologist, who wrote me the following letter, dated October 17, 1903:

"Mrs. H. first consulted me last spring, having had an attack of what appeared to be rather transient pelvic inflammation. I found a slight thickening of the structures to the left of the uterus, but inasmuch as the tenderness had entirely disappeared, and because there were then no subjective symptoms, I advised no treatment. About four weeks ago I saw her in consultation with

her physician, and found a large, fixed, irregular, non-fluctuating mass to the left and posterior to the uterus. There was no tenderness on pressure. Her physician suggested that the growth might be a rapidly developing papilloma. On opening the abdomen this was found to be the case, the papillomatous disease having developed until it completely blocked the pelvis minor, especially on the left and posterior to the uterus. The surrounding peritoneum was also studded over at points with the same disease. We did not think it wise to pursue the operation to the removal of the growth, because we felt quite sure that no permanent satisfactory result could be obtained. We therefore closed the wound without drainage. Mrs. H. made an uneventful recovery from this incision. Mr. H. will hand you some microscopic sections from the growth, which you will find confirm our diagnosis of papilloma. I regret that this case gives so little promise of recovery. At the time of exploratory incision there was considerable ascites."

This operation had been performed on September 7, 1903.

When the patient came to me she was in a fair condition; appetite fairly good, no pain, but considerable ascites, which impeded walking. No malignant structure was found in the microscopic examinations handed to me. The histological texture was similar to the ordinary papilloma (Fig. 1). I decided to perform another operation.

This took place on November 13, 1903. I made a rather long incision. It is most important in such cases to be able to see well and to have sufficient space in order to work easily. Flowing of a great quantity of yellow-colored ascites ensued.

The pelvis minor was blocked by a cauliflower mass of both ovaries and tubes, embedding the uterus. No scattered vegetations were found on the peritoneum, parietal or visceral; such growths had disappeared, for they were expressly pointed out by the surgeon who performed the first operation. This can be compared with the disappearance of tuberculous disseminated tubercles on the peritoneum after laparotomy.

Placing my hand in Douglas' sac I lifted the papilloma and delivered it out of the abdomen. Two forceps were fixed on

both broad ligaments, which were then incised, and the cervix was also excised after liberation of the bladder, in order to perform a subtotal hysterectomy; the cervix was then sutured; I then removed a large quantity of fungus left in Douglas' sac and several disseminated small particles elsewhere. Abdominal drainage with Mikulicz's sac.

The tumor was as large as both fists. It was formed by two masses which had destroyed both ovaries and two-thirds of the tubes, which were reduced to thickened stumps, as if they had been amputated. The uterus was entirely covered by the bilateral spreading of the vegetations, but it was not degenerated.

The patient made an uninterrupted recovery, and in April, 1904, she was in a much improved condition.

I have given prominence to this case because it is a typical one. It is still too recent to form a prognosis, but recovery remains complete six months afterward. The patient, who had become an invalid, has returned to her ordinary manner of living.

Experience has proved to us that such a recovery can last for a long period. It also shows that two other processes are possible: (1) local recurrence without malignancy, and (2) recurrence with undergoing malignancy (epithelioma and sarcoma).[1]

What must be done in a recurrent case?

One must not give up, but perform another cœliotomy and again remove the new-growths. In one case I have performed three successive cœliotomies, and so have been able to take away the first time vegetations from the thickened omentum and a small cyst grafted on the mesentery; on a second laparotomy I removed free papillary growths contained in a circumscribed cavity of the peritoneum situated between the liver, the spleen, and the diaphragm. A third iterative laparotomy was made for recurrent ascites. In the course of this last operation I noticed that the peritoneum had again become smooth and

[1] Pseudomyxomatous peritonitis or pseudomyxoma of Werth has also been noticed; farther on I will quote an example of this kind. This modification is observed when abundant detached fungus has remained in the peritoneum.

bright, and that there was but a single nodular growth on it. The patient made a complete recovery. These successive laparotomies produce these results: they first allow the removal of the relapsed growths scattered over disseminated vegetations or over old adhesions, and they also permit the taking away of vegetations which have been detached and lost in the peritoneum during the first operation.

Cœliotomy seems to have a modifying influence on the peritoneum and to produce the disappearance of the disseminated papillary growths and of the ascites the same as it produces the disappearance of nodules and ascites in tuberculous peritonitis.

Recovery after these iterative cœliotomies is sometimes of rather short duration, and the tumor relapses as malignant. I will mention as an example a patient who has been observed by me for ten years. The following is a summary of her history (the first part has been published in the inaugural dissertation of my pupil, Cazenave, 1895):

In October, 1888, Mrs. M. V. de C., aged thirty years, was admitted to the "Hôpital de la Pitie," in the service of Dr. Pollaillon. This surgeon performed a laparotomy and removed a papilloma of the right ovary. The abdominal wound, which had been drained, became fistulous, and allowed continuous oozing of ascitic liquid, carrying small remains of vegetations. This somewhat abundant flowing kept on without weakening the patient, who returned to her ordinary occupation. Four years later (1892) an obstruction appeared at the opening of the peritoneo-cutaneous fistula, which increased by degrees. The patient consulted me two years later. The papillary tumor was as large as an orange, and extended down to a large intra-abdominal mass. The quantity of ascitic liquid evacuated in twenty-four hours was about one litre. General condition was good. Cœliotomy was performed on June 4, 1894. A large papilloma was removed, developing from the adnexa of the left side. Complete recovery fo six years (1900). The first operation was performed twelve years before.

In 1900 a solid tumor began to appear in the abdomen, which became adherent to the skin of the inguinoiliac region. These tumors seemed to be developed from the lymphatic glands. The following year (1902) the compression of the iliac vein produced an elephantiasic œdema of the leg. In spite of this her general health kept good; she had no pain. In 1903 the patient began to suffer, œdema increased, involving both legs, and extended to the breast. The abdomen was filled with a solid mass, in every way adherent; in some places the skin was thin and violaceous colored. There is no doubt about malignancy developing, but this happened fourteen years after the first operation. I do not think this is a discouraging result.

Proposition 5. *The frequency of successive invasion of both ovaries by papillary tumors indicates that the adnexa should be removed on both sides, even if one is still healthy, especially on women who are near the change of life. In young women it would be better not to remove a non-diseased ovary.*

Conservative operation must be performed in young women unless the tumor removed seems undoubtedly cancerous. Then the best plan is to make a complete removal, even to performing hysterectomy.

Proposition 6. *In bilateral papillary tumors operative technique will be greatly improved by performing subtotal or total hysterectomy, according to the case.*

Hysterectomy should be total if malignant degeneration is feared. If the bilateral papilloma appears to be a benign one, subtotal hysterectomy should be better, as it is more rapid and less serious.

Hysterectomy in bilateral tumors simplifies to a considerable extent the technique and makes control of the bleeding much easier.

Proposition 7. *Drainage is not necessary when cysts have no outside vegetations and when there is no ascites. In case of ascites it is better to drain for a while the peritoneal cavity. Incomplete removal or even an exploratory section in inoperable cases is often accompanied by a diminution of ascites, with local and general improvement.*

Whenever the peritoneum contains liquid I think it useful to drain the abdomen for three or four days with gauze, and the following days with a tube. In some special cases Mikulicz's dressing may be necessary, but I never allow it to remain longer than four days.

Well-known cases of incomplete removal of papillary tumors have made good recoveries. Of course, that does not mean one must as a rule perform an incomplete operation. I have previously mentioned[1] that exploratory cœliotomy, especially if followed with temporary drainage, has good effect even in malignant cases and inoperable neoplasms. Now and then ascites is cured for a long while, and the progress of the disease seems to cease.

I consider that an incision followed by drainage is preferable to tapping in all cases of ascites. The operation is a less doubtful one, and the improvement obtained lasts longer.

[1] See Observation IV. in Cazenave, loc. cit., p. 41.

DISCUSSION.

Dr. Dudley P. Allen, of Cleveland.

I should like to say a word or two on this subject, because I have been persuaded that there is much more hopefulness in operating on cases of papillary cystoma now than by the original method of opening the abdomen, and, finding these growths, abandoning the operation as hopeless. In this connection I desire to report one or two cases, because they are germane to the subject. The first case of the kind I ever had, which was a serious one, was that of a woman whose pelvis was literally full of papillary growths. Almost the entire omentum was involved. There was a mass upon the abdominal wall four or five inches in diameter, with numerous other smaller growths studded over the abdominal wall and intestines. The growth on the abdominal wall was removed, together with almost one-half of the omentum. The removal of this enormous mass was attended by such bleeding as I have never seen before or since, but to my surprise the patient seemingly made a perfect recovery. Two years afterward ascites returned, and a secondary operation was made, again followed by recovery. An interesting point was that at the secondary operation the numerous growths which had existed upon the abdominal wall and intestines had seemingly disappeared. A second growth was confined to the small pelvis. The patient survived the second operation for many months, and then died.

The other patient was operated upon a number of years ago for a tumor on the right side, which proved to be a papillary cystoma. This was shown by both microscopic and histological examinations. Two years later the patient had a growth on the left side. This was removed, and found also to be a papillary cystoma, very largely adherent, but much less cystic than the original growth. The oozing was so excessive that it was thought wise to use a Mikulicz tampon. A fistula remained, and there was some discharge of fluid, as has been described. An interesting thing was that some months later, the fistula remaining, secondary growths made their appearance, not along the track of the fistula, but on the integument of the left side. Histological examination of these growths after death proved them to be medullary carcinoma. This was the most striking case I have ever seen of what might be termed autoinoculation with malignant growths, and a point of great interest is that the original growth was perfectly typical, while the papillary cystoma, the growth upon the skin, was perfectly typical of medullary carcinoma.

Dr. James E. Moore, of Minneapolis, Minn.

I think that we are greatly indebted to the writer of this paper, for the reason that I feel he has given us courage concerning a point we have all felt a little discouraged about at times. Personally, my experience in operating upon papilloma of the rectum, for instance, has been very unsatisfactory. The majority of the patients have died within a comparatively short time, say two or three years, of well-marked malignant growth of the rectum. It has been a mooted point for a long time among pathologists as to whether or not we should classify these papillomata as benign or malignant, and it would seem from what Professor Pozzi has taught us to-day it would be safer to operate upon them with the idea that they are malignant, so that we can hope in a large percentage of cases in the future to get good results. Those of us who are old enough have watched cases of papillomata of the bladder, for instance, go on for twenty years, doing the best we could for them, and finally they would die of unmistakable malignant disease. The question arises whether the disease was malignant from the beginning or whether there was a transition from one kind of growth to another. This is still a mooted point, as I understand, but I think we all feel that it is our duty to remove these papillomatous cysts when not far advanced. This paper has been encouraging to us, and I feel that it will be my duty hereafter to operate upon some of these more advanced cases, hoping that better results may be secured.

Dr. W. B. Coley, of New York City.

I would like to place on record one case as showing the comparative benignity of papillary tumor of the ovary. In the spring of 1895 I operated on a woman, aged seventy-one years, who was sent to me for an irreducible right inguinal hernia. In operating, instead of finding the omentum, I found bunch or grape-like cysts, which were removed and the wound closed. The wound healed by primary union. At the time of the operation a large tumor was discovered in the abdomen. No consent was obtained for an abdominal operation. Three months later, however, I opened the abdomen and found the ovary on the right side to be about the size of a cocoanut, and a perfectly typical papillary mass on the left side, about the size of two fists. The entire abdominal cavity was filled with vegetations and grape-like masses. There was a moderate amount of ascites. The case was regarded as absolutely hopeless. All of the tumors were removed, as well as both ovaries, the abdomen cleaned out, and the wound closed with gauze drainage. The woman recovered, and remained well for seven years. I examined her seven years after the operation, and there was no evidence of return.

I have not seen her since 1902, but so far as I know she is living. This case seemed hopeless at the start, but the patient had lived for more than seven years after the operation, showing what good results we may get in far-advanced cases.

NOTE.—July 20, 1904. I have just heard from the patient and learn that she has had a return of the trouble, with marked ascites requiring frequent tappings, and is not expected to live more than a few weeks.

DR. A. J. OCHSNER, of Chicago.

There can be no doubt but what the conclusions which Professor Pozzi has given us are of the greatest importance. There is a distinct clinical difference between the grafting of a papilloma and invasion or metastasis. In cases in which there is a dissemination by grafting over the peritoneum, there may, at the same time, be an invasion of the broad ligament; so that unless one removes the uterus at the same time, the papillomatous grafts upon the peritoneum may disappear, but the invasion of the broad ligament may remain, or a sufficient amount of it, to form a secondary tumor later, which will not occur if the other conclusion which Professor Pozzi has reached, namely, of removing the uterus at the same time, is followed. This plan I have adopted in a number of cases, and, although the time is too short, it has seemed most reasonable to me that the hard induration in the pelvis, which one first notices in the recurrence of these cases, has been less frequent since adopting that plan. I believe the conclusions in regard to removing both ovaries are also sound, and I have done it. I have removed the uterus, even in patients younger than have been advised, although it is a questionable practice, because some of these women who have had papillomatous cysts removed from one side have borne children afterward.

DR. L. L. MCARTHUR, of Chicago.

I would like to ask Professor Pozzi, in closing the discussion, whether it has been his experience to meet with any secondary infections of these papillomatous growths, and what, if any, conclusion he has arrived at as to their etiology. In the past we have been taught that possibly irritating discharges from the fimbriated extremity of the Fallopian tube were blamable. It has been my experience in removing a papillomatous growth to find it associated with tuberculosis of the tube, and in varying points of the papilloma to find miliary tubercles with the bacteria capable of being stained invading the terminal filaments of the papillæ.

Professor Pozzi. With reference to Dr. Moore's remarks concerning papilloma of the rectum or bladder, no comparison can be made between papillary growths of these different organs. Each of these organs has its own pathological history. My paper was confined very largely to the ovaries and tubes.

As to operating on young women for papillomatous cyst of the ovary, I think it is wise, whenever it is possible to do so, to save one of the ovaries, or at least part of an ovary, for the purpose of fecundation.

With regard to some women in this country, I saw in a paper recently published that they were not apt to bear children after these operations. My experience teaches me that this is quite wrong. It is important to give a woman the possibility of having children, and so when you remove both ovaries in a young woman nervous symptoms are to be feared, and it is better, if possible, to leave one ovary, or part of it, and await the manifestations of further symptoms. If symptoms sufficiently urgent should manifest themselves later I would not hesitate to do a second laparotomy for the removal of the other ovary. I recall very distinctly a woman who bore one child after the removal of her right ovary. The disease then appeared in the left ovary, which I removed. However, she bore a child, and that was a source of great comfort to her.

With regard to Dr. McArthur's question, I have not come to any conclusion in regard to the etiology of secondary infections of papillomatous cysts. I think sometimes that a cervical metritis is a predisposing cause of epithelioma.

A CASE OF ACUTE PANCREATITIS ASSOCIATED WITH GALLSTONES.

By JAMES BELL, M.D.,
MONTREAL, CANADA.

The great importance of the question of the part which is played by the presence of gallstones in the causation of acute pancreatitis has led me to present the following somewhat detailed report of a case of acute pancreatitis, the course of which was such as to enable me to demonstrate certain facts having an important bearing upon the diagnosis, prognosis, and etiology of this condition, and more especially of the relations between pancreatitis and cholelithiasis.

The patient, Dr. F., aged thirty-three years, was admitted to the Royal Victoria Hospital March 9, 1898, for "intestinal obstruction," with the following history: On the morning of March 3 (six days previously) he was awakened between five and six o'clock with a sensation of oppression or "crowding" in the epigastrium, which soon developed into actual pain. The pain increased all day and through the night, and, while it did not become extremely severe, morphine was required for its relief. Sometime during the night he began to vomit, and continued to vomit very frequently until he came to the hospital. Purgatives were administered, but were not retained; enemata were employed but without effect until the evening before his coming to the hospital, when a small quantity of liquid feces was passed but no flatus. Distention of the abdomen, which was moderate when he came to the hospital, had been very marked during the first two days of his illness. The pain ceased on the second day. The temperature had been normal until the evening of the fifth day,

when it rose to 100°. There was not at any time any urinary disturbance.

He also gave a history of an attack of abdominal distress, not amounting to pain, ten years before, and of two attacks of abdominal "crampy" pain similar to the present attack, but less severe, although accompanied by vomiting and constipation. One of these had occurred three years and one two years previously. He had not, as a rule, been constipated. He had been in the habit of having a stool daily, but had often felt that the evacuation was not entirely satisfactory—*i. e.*, that it did not give complete relief. For some years he had been troubled with what he described as "sour stomach," consisting of acid eructations and heartburn, which occurred frequently but at irregular intervals. This had been especially troublesome during the past year. He had suffered from very severe diarrhœa for a long time as a child, and had been told that his life was despaired of at that time. Apart from measles, whooping-cough and scarlatina, he had had no other illness except as already described. His maternal grandmother and one maternal aunt had died of consumption.

I saw the patient on his arrival at the hospital (I had been notified by telegram and had been asked to be prepared to operate for intestinal obstruction); he was a short, stoutly built man, his face was flushed and his mucous membranes somewhat livid; there was no sign of jaundice, the tongue was heavily coated with brownish fur; the face was somewhat anxious, and the expression dull, and he answered questions very slowly. The abdomen was moderately distended, especially in the epigastrium; there was no rigidity, no palpable mass, and no spontaneous pain, although he was somewhat tender over the epigastric region. No abnormality was discovered about the liver, spleen, or thoracic organs. There were frequent eructations of gas. The urine was normal, the pulse 90, and the temperature 99.4°. He had passed a little flatus on the train on his way to Montreal (he had come 140 miles by train), and altogether I did not think he was suffering from an organic obstruction of the intestine, and did not operate. I looked upon the condition as a toxic one of some kind, and sus-

pected pancreatitis. The record for the next two days is as follows:

March 10th (twenty-four hours after admission). Patient had vomited seven or eight times, and the use of enemata every two hours had resulted in the passage of some flatus and several loose stools. Temperature, 100°; pulse, 100; looks toxic. There was no more vomiting from this time.

March 11th. Mildly delirious in the night, trying to get out of bed, etc.; passed urine involuntarily; bowels now move freely with enemata. Urine acid, specific gravity 1018, contains a trace of albumin, but is otherwise normal.

For the next eight days he remained dull and apathetic, with a trace of albumin, but no sugar, in the urine, which was passed, at times, involuntarily. He then brightened up and complained again of "sour stomach" (acid, burning eructations) very frequently. The bowels moved freely and nothing unusual was noted in the stools at any time. As he grew brighter the sensation of "crowding" in the epigastrium returned, and, as before, increased until it became actual pain and required the use of morphine hypodermically for its relief. The temperature during most of this time was about 100° in the evening and 99° in the morning. There was no distention of the abdomen, but a point of special tenderness developed about two inches above and to the right of the umbilicus. The albumin disappeared from the urine, having been present only for about eleven days (March 11th to 22d).

March 26th. An exploratory operation was performed. The patient took ether badly. A median incision was made from the ensiform cartilage to a point about one inch below the umbilicus. The abdominal wall and omentum were very fat. There was no free fluid in the peritoneal cavity. Areas of fat necrosis were apparent on the omentum, small intestine and mesentery, varying in size from a pinhead to a pea. In other places irregularly fused areas were visible. The pancreas was swollen, firm, and somewhat elastic, especially about the head. Immediately above the head of the pancreas was a mass of swollen lymphatic glands lying on the posterior abdominal wall, partly fused and partly

separate. The mass was as large as a man's fist. The liver, gall-bladder, and bile-ducts were normal, but in the gall-bladder two or three stones could be felt free in its cavity. With these exceptions nothing abnormal was discovered.

Owing to the patient's condition and the apparently serious lesion of the pancreas, for which no operation seemed to be indicated, it was not thought wise to interfere with the gallstones. Recovery from the operation was quite satisfactory, but the same symptoms of "sour stomach" and pain and tenderness in the epigastrium persisted, and on April 5th, nine days after operation, he had a slight chill. He gradually recovered, however, and was discharged from hospital on April 20th with scarcely any symptoms. I saw him one year later, and he looked well and reported that he had steadily improved and for some time had been feeling quite well.

On May 9, 1901, he was readmitted, with obstructive jaundice. For a year and a half, or a little more, after the operation he had felt pretty well. Then began attacks of pain of the character of biliary colic, sometimes followed by jaundice. The previous attacks of "crowding" and oppression had been quite different in character. These attacks became more frequent and more severe until June, 1900, when the attacks became very frequent and the jaundice was persistent, though varying in intensity from time to time. From January to April, 1901, he was free from pain, and the jaundice was less marked. (The urine is said to have been analyzed at this time and found to be free from bile.) In April the attacks of pain became more frequent and more severe and the jaundice became extreme.

When he returned to the hospital on May 9, 1901, he was emaciated and deeply jaundiced, but free from pain, fever, or other symptoms except those directly associated with the jaundice. The acid eructations were not troublesome, although they had not entirely disappeared.

On May 25, 1901, the abdomen was reopened through the old scar. Considerable adhesion was found between the stomach, colon, omentum and liver. There was no fat necrosis visible

anywhere. The pancreas was perhaps slightly enlarged, hard, firm, and somewhat nodular; the liver was large and dark in color, with smooth, rounded edges; the gall-bladder was shrunken down upon a stone, the common bile-duct was dilated as large as the little finger, and a stone was found in the ampulla projecting well into the duodenum. This stone was removed from within the duodenum (choledocho-duodenostomy). The stone was also removed from the shrunken gall-bladder. The stones were each about the size of a large cherry, faceted, black on the outside, but green and yellow in the interior and largely composed of cholesterin. Cultures on gelatin plates showed (1) the bacillus coli communis, and (2) the bacillus coli verus. The cystic duct was occluded. A drainage-tube and gauze packing were carried through the abdominal wound from the incision in the gall-bladder. The patient made an uninterrupted recovery, and was discharged from the hospital on June 13th, exactly five weeks after operation, with his wounds healed, free from jaundice, and feeling perfectly well.

Two letters received from this patient, June 27, 1901, and May 29, 1904, respectively, complete the record. They were written in reply to letters from me. The first, in reply to my request that he should write as fully as possible a history of his illness, with a statement of his condition at that time, is as follows:

"I began to be bothered with acidity of the stomach about 1888–1889. It occurred three or four hours after meals, often in the afternoon and oftener in the evening. It was generally benefited for the time being by taking a meal. I gradually increased in weight, from 165 to 195 pounds, in 1894–1895, and had nothing to complain of beyond a measure of heartburn and some pyrosis, with slight irregularity of the bowels, until April, 1895. I may say that I received no benefit from alkalies or acids, though I received temporary relief from alkalies at the time of acidity, and very generally resorted to them in small doses for that purpose. During most of this time I was following the sedentary occupations of a master in the Collegiate Institute and of a medical student, and ate a good meal at fairly regular hours three times a day.

"In April, 1895, occurred the first attack of epigastric pain. It resembled an ache, something like the sensation experienced by receiving a severe blow over the pit of the stomach. This lasted for three or four days and was accompanied by constipation (contributed to by opiates), and a single attack of vomiting of a very green, acid, fermenting matter which brought no relief to the pain. This experience was repeated about one year later. During the next two years I had attacks fairly often, with this difference in their character, that they lasted only a few hours or the greater part of a day, and were occasionally accompanied with vomiting of the acid contents of the stomach. The pain was severe, throwing me always into a more or less profuse perspiration. In the intervals I considered myself well, but still continued to have considerable acidity of the stomach with slight irritability of the bowels. Up to this time, 1898, jaundice was not present, but the urine was always very high colored during and after each attack.

"In the beginning of March, 1898, these attacks culminated in one accompanied with symptoms of obstruction of the bowel. The pain resembled, as stated above, the sensation experienced from receiving a severe blow over the stomach, with its hollow ache, difficulty in getting one's breath, perspiration, etc. It required morphine in very fair doses for twenty-four hours for its relief, and the next day vomiting, characteristics of obstruction, set in.

"After returning here from the hospital I was troubled with acidity of stomach, but after a few weeks that symptom became a mere bagatelle. The fall of 1898, the year 1899, and the first six months of 1900 I felt fairly well. During this period I had attacks of pain at irregular and sometimes long intervals, these being followed by jaundice, clay-like stools, and high-colored urine, lasting a few days. About a year ago, however, I began to feel different—to feel miserable almost continuously, was all the time jaundiced, with urine and stools and irritation of the skin indicative of that condition. I improved somewhat in January, and felt somewhat better until April, during which month I had pain, due to gallstones, mostly every day.

"I may say that during the last three years I have been able to eat quite a number of articles of diet that prior to that time I was accustomed to regard as hurtful to me, and wisely, or unwisely, have indulged somewhat freely in starchy foods, for they certainly appeared to be agreeing with me. And while I have written considerable regarding acidity of the stomach, very rarely was I made miserable with it in a degree at all comparable to that from which I suffered for a few days after each of the operations, and especially the one of three years ago.

"You will be glad to hear that I am getting along very well, indeed, and with the encouragement I have received this spring, I hope to be 'fit' when I go to work again sometime next month." (June 27, 1901.)

The second letter is simply a statement of his health at the present time, three years after the second operation. In it he says:

"In reply to your letter I hardly know what I can say, further than that I have enjoyed excellent health the last three years. It is only rarely indeed that anything occurs in the way of a little flatulence and a suggestion of acidity of the stomach—to indicate even some slight indigestion—and that is the case, though I do not take any special care as to what I eat or when I eat. As for indications of any further liver or gallstone trouble, I know of none. I must say frankly that I have never made any examination of the urine, for the reason that I do not know that I have any of the rational symptoms of diabetes. In conclusion, I am in the habit of regarding myself as being healthy, well, and strong."

The demonstrated facts in this case are:

1. That in March, 1898, there were all the characteristic lesions (as well as the signs and symptoms) of acute pancreatitis, and at the same time an apparently quite healthy liver and gall-passages, with two or three stones in the gall-bladder.

2. That all signs and symptoms of pancreatitis disappeared, the patient recovering and considering himself quite well until nearly two years later, when a new train of symptoms developed which were characteristically those produced by gallstones.

3. Three years after the attack of acute pancreatitis it was demonstrated that, while extensive and serious pathological changes had taken place in the gall-bladder and bile-ducts, all local signs of acute pancreatitis had (during the same period of time) entirely disappeared (subperitoneal fat necrosis and swelling of the pancreas). That is to say, that acute pancreatitis developed before there were any pathological changes in the gall-bladder and bile-ducts, and that while such changes were taking place, the pancreatitis was recovered from.

These facts would seem to be at variance with the modern views of the etiology of acute pancreatitis which tend to attribute this condition in a general way to a pathological change in the common bile-duct due to the passage of gallstones from the gall-bladder to the intestine. It is true that stones may have been passed previously; even a stone may have been lodged in the ampulla and may have been overlooked at the first operation, but the symptoms do not suggest anything of this kind, and certainly a careful exploration failed to discover it. On the contrary, the patient, a physician, draws a definite line of distinction between the symptoms prior to the pancreatitis—"sour stomach, crowding in the epigastrium," etc., and those which developed later and led to obstructive jaundice. The two attacks of "crampy" pain within the two years prior to the attack of acute pancreatitis, may, of course, have been due to the passage of gallstones. On the other hand, may not the severe and prolonged diarrhœa in childhood have had some causal relation to the later development of acute pancreatitis? Or may not both these conditions (cholelithiasis and pancreatitis) have been due to a common cause? It seems to me that the answer depends upon the interpretation of the early painful attacks—whether they might have been due to gallstones or not, and it must be admitted that the faceted condition of the two stones removed lends color to this theory.

A CLINICAL AND EXPERIMENTAL STUDY UPON THE USE OF THE SEGMENTED RING IN GASTRIC AND INTESTINAL ANASTOMOSES.

By FRANCIS B. HARRINGTON, M.D.,

AND

ALFRED H. GOULD, M.D.,

BOSTON, MASS.

(From the Surgical Laboratory of the Harvard Medical School)

In 1902 a segmented ring was described by Harrington,[1] the objects of which were two: (1) to furnish a mechanical aid to assist in the rapid and safe anastomosis of the intestines, and (2) to provide a contrivance collapsible into such small segments that their subsequent passage through the intestines would be devoid of danger or pain. The favorable reception of even the ring by the profession, during the past two years, has encouraged us to make a report of personal cases to date, accompanied by the results of a series of animal experiments illustrating the process of repair.

Description of Ring. The ring is made of hard aluminum in four sections. These sections are jointed firmly together by a small bar of steel which has a shoulder and a screw thread, and which serves as a handle. The outer surfaces of the ring are grooved to hold the ends of the intestines, which are tied in place by catgut purse-string sutures. The segments fit together by means of sliding tongue-and-groove joints so rounded that they will not cut or catch in the tissues. The ring is made in three sizes. (See Fig. 1.)

[1] Boston Medical and Surgical Journal, November 6, 1902.

Diameter.	*Width.*	*Weight of individual segments.*
$\frac{5}{8}$ inch	$\frac{1}{2}$ inch	10 grains.
$\frac{7}{8}$ "	$\frac{5}{8}$ "	20 "
$1\frac{1}{8}$ "	$\frac{5}{8}$ "	30 "

The middle size is best adapted for general use; the largest may be used for sutures of the large intestines; the smallest size is best adapted to children and to cholecystenterostomy.

ANIMAL EXPERIMENTS.

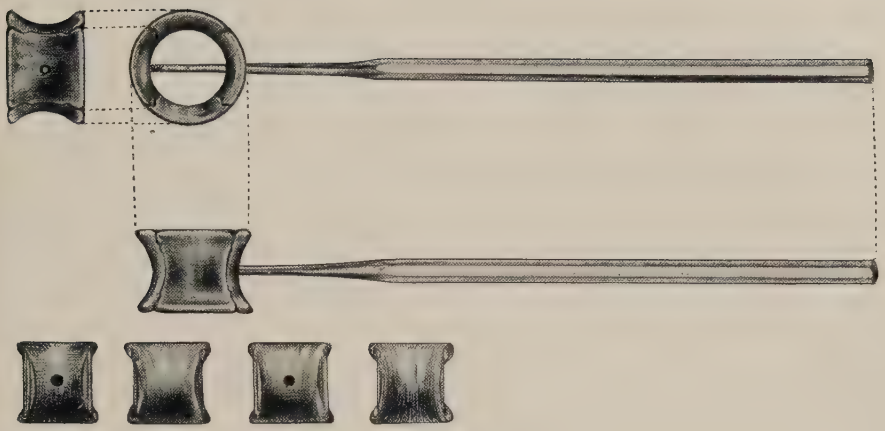
Technique. The same technique is used both for end-to-end and for lateral anastomoses; but a slight difference in details makes a separate description necessary.

End-to-End. Clamps are applied in the usual manner a few inches from the field of operation, and a gather-stitch of No. 2 plain catgut is placed on either side of the area to be resected. This stitch circles the intestine with bites deep enough into the muscular coat to insure its not slipping, and, in order to save time later, the catgut is lightly tied with one-half of a surgeon's knot without drawing the purse-strings tight. (See Fig. 2.)

The bowel is next cut away up to one-eighth of an inch from the gather-stitches, because a wide margin forms a wide inturn and a correspondingly thick scar. The weak point in mechanical aids is the difficulty in obtaining a secure joint at the mesenteric border, a danger which is avoided with the ring by putting in a mattress-stitch at this spot. This stitch includes a portion of the mesentery on each side, but is not tied at once. (See Fig. 3.)

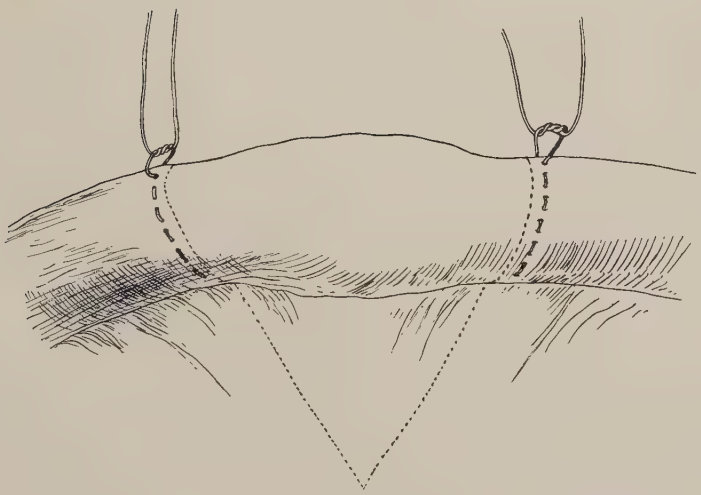
The ring is now introduced and one gather-stitch tied. The mattress-stitch is next tied, followed by the tying of the second gather-stitch. The cut bowels now lie smoothly end-to-end, and, by use of the handle, can be easily moved about in convenient positions for sewing. The mainstay of the suture is a Cushing continuous stitch of silk or linen thread which penetrates the bowel into the muscularis mucosæ. This stitch starts just to one side of the steel handle and passes around the intestine with occasional knots until it reaches the handle again from the other side. (See Fig. 4.) The handle is now unscrewed, leaving the ring held together by the purse-strings, and the suture continued over

FIG. 1.



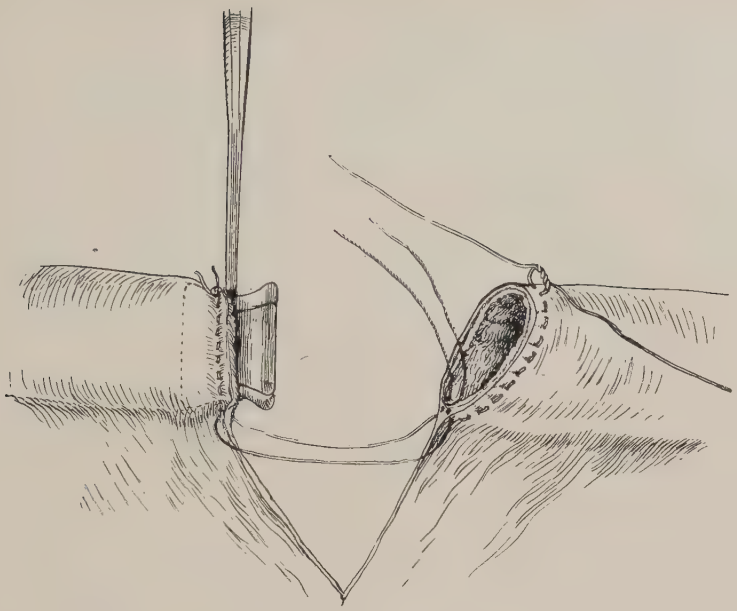
The segmented ring.

FIG. 2.



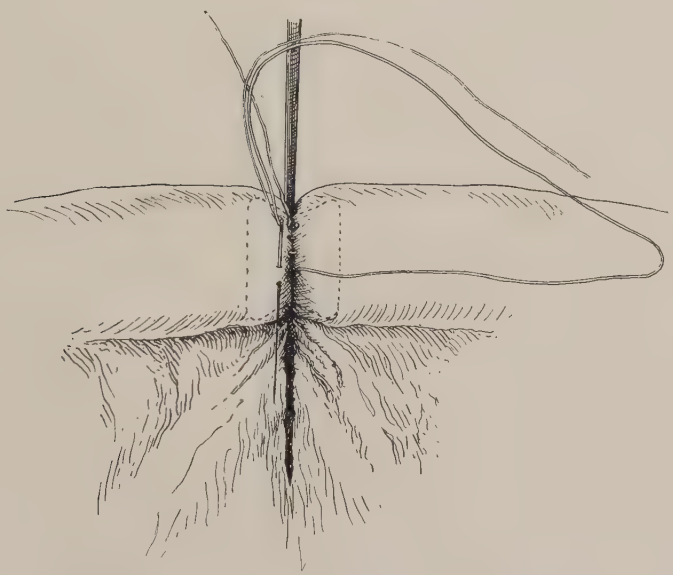
Preliminary introduction of purse-string sutures tied with one-half surgeon's knot.

FIG. 3.



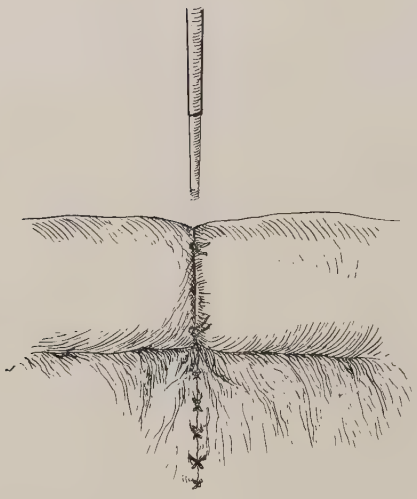
Bowel resected, ring half introduced, one gather stitch tied, mattress suture to mesenteric border.

FIG. 4.



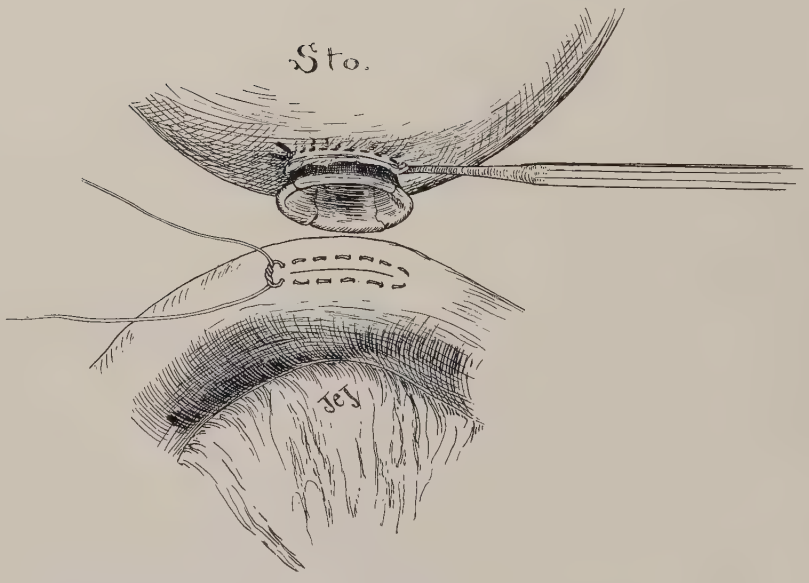
Continuous stitch beginning at one side of the handle.

FIG. 5.



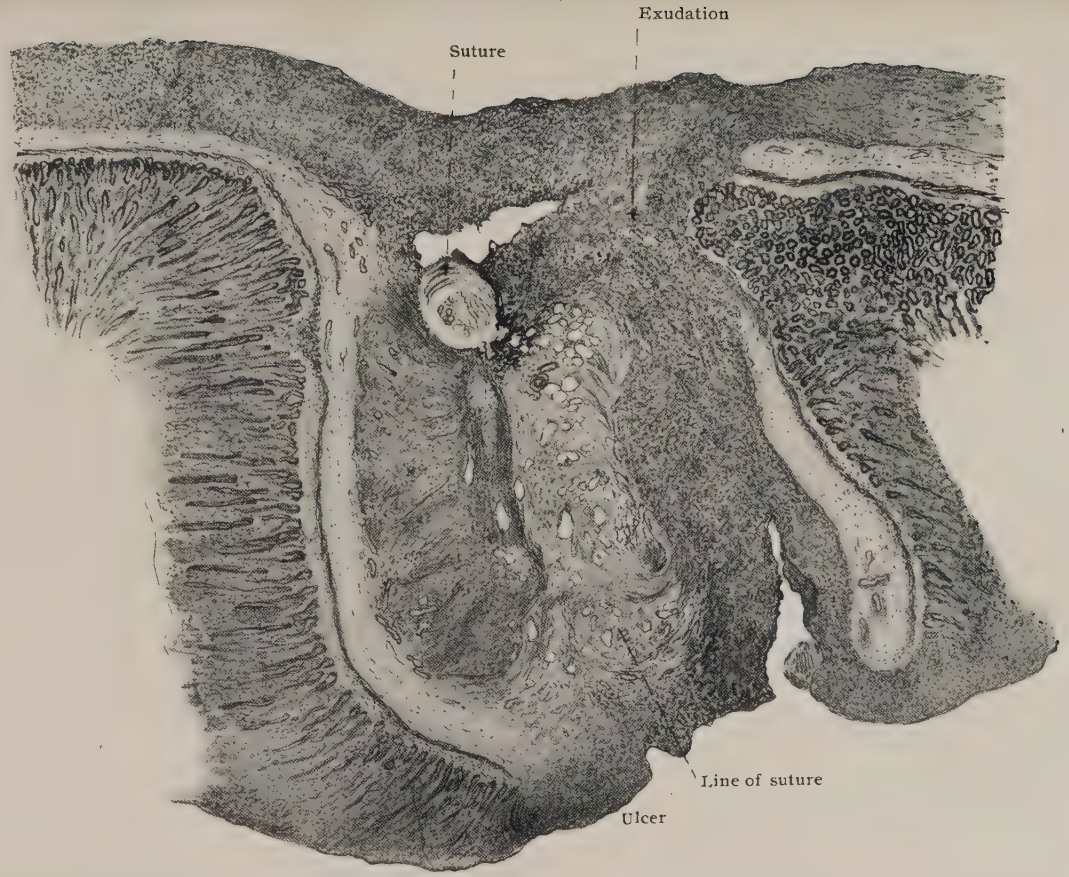
Handle unscrewed, suture completed.

FIG. 6.



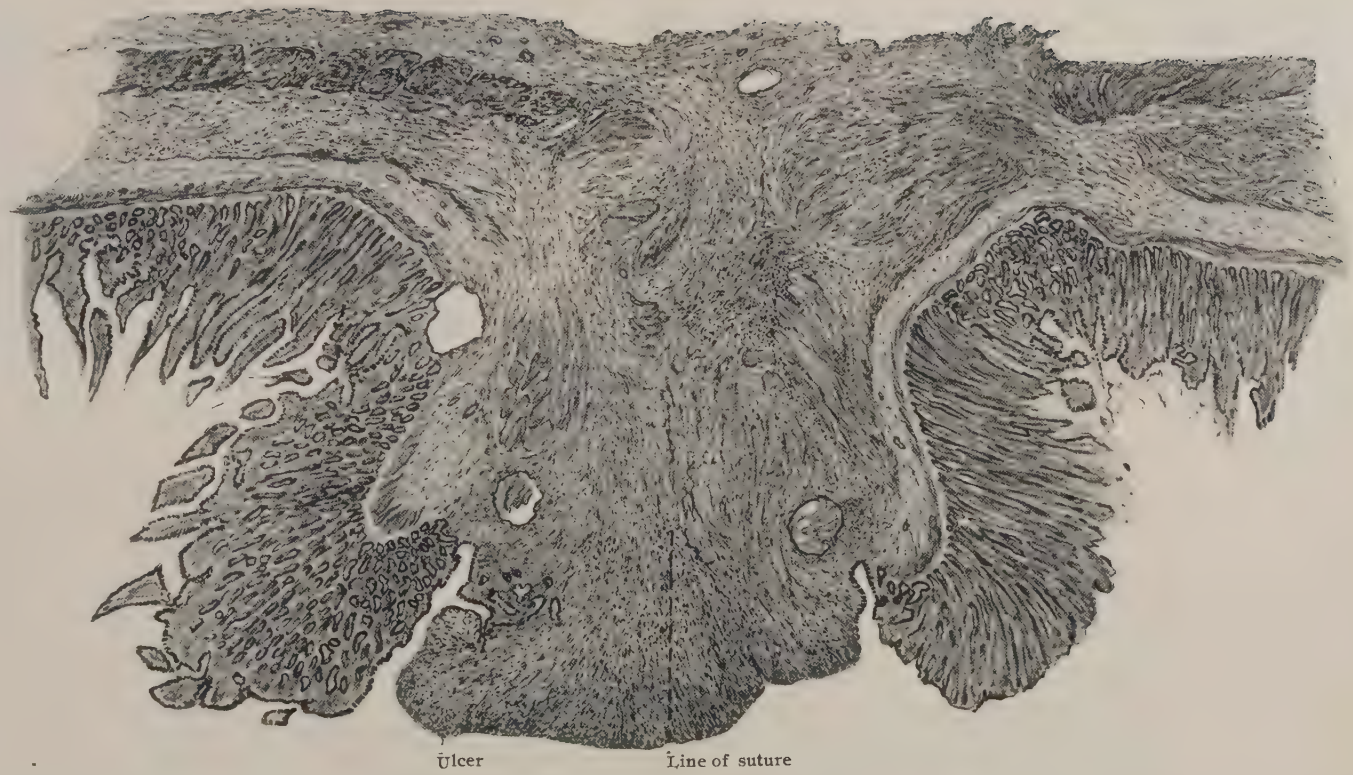
Gastroenterostomy. Shows parallel positions of two arms of purse-string stitch. Purse-string tied on stomach side.

FIG. 7.



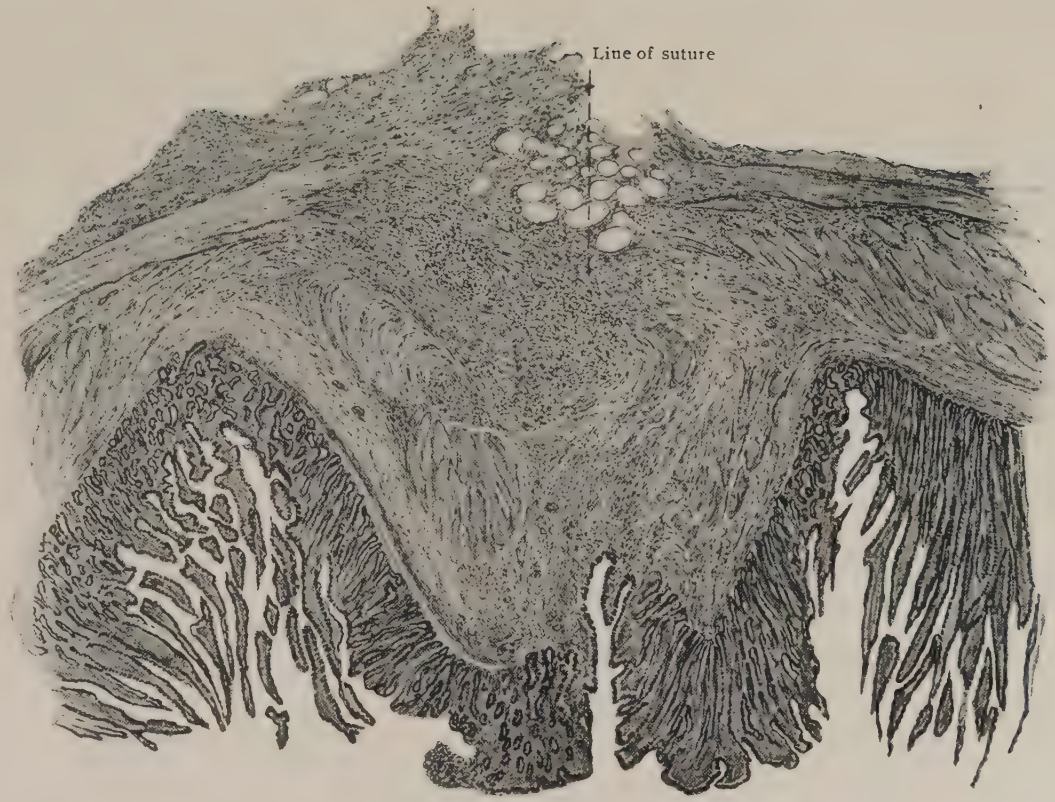
End-to-end anastomosis, three days. Note ulcer over inturned edges. Glands of mucous membrane on either side of ulcer necrotic and infiltrated.

FIG. 8.



Lateral intestinal anastomosis, five days. Exudation almost entirely organized. Ulcer of denser fibrous tissue, new-formation of mucous glands at margin.

FIG. 9.

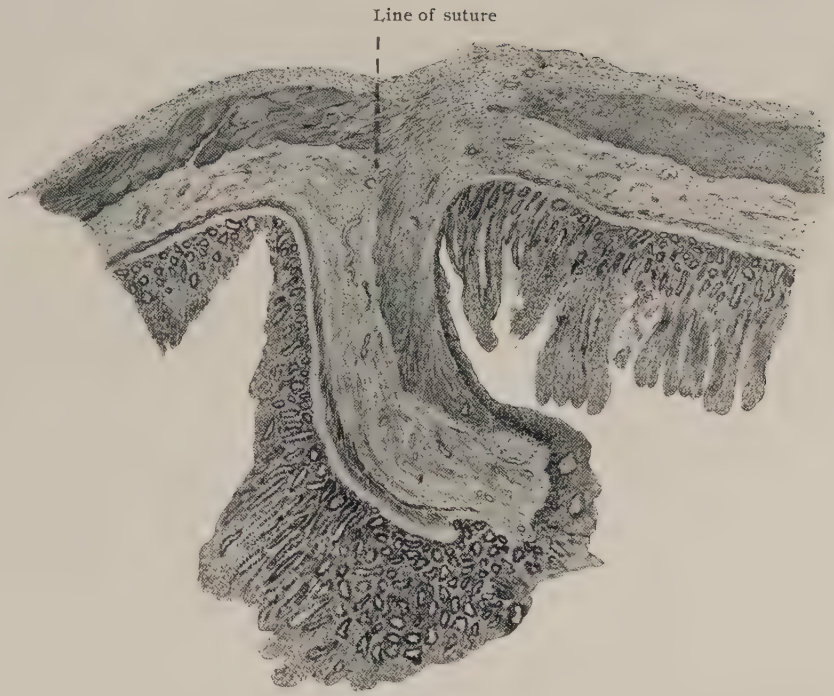


End-to-end anastomosis, eight days. Exudation entirely organized. Ulcer covered by newly formed atypical mucous glands.

FIG. 10.

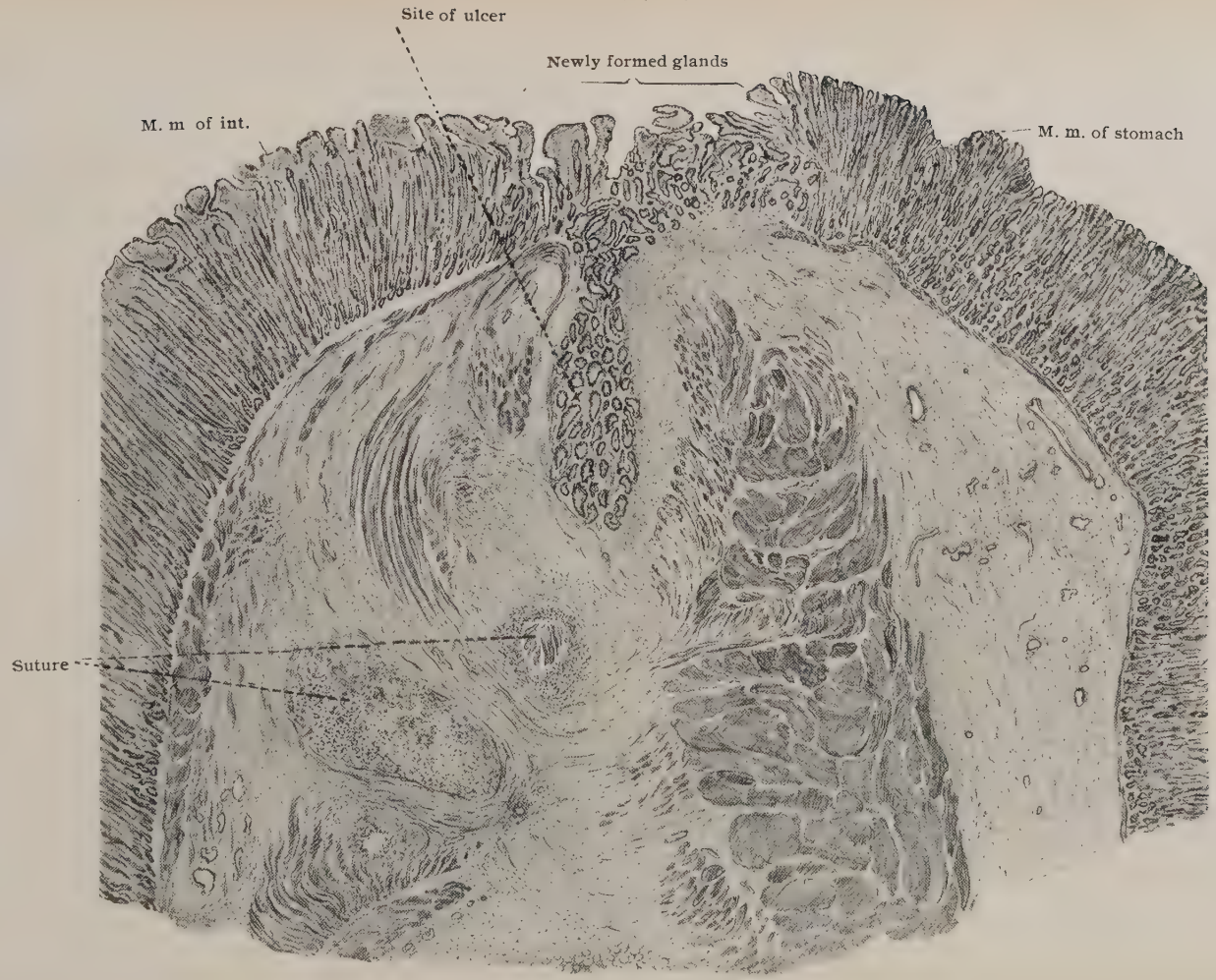
Gastroenterostomy, twelve days. Floor of ulcer formed by infiltrated granulation tissue and covered by epithelial cells arising from epithelium of the stomach. Observe that rate of growth of gastric is much more rapid than that of the intestinal epithelium.

FIG. 11.



End-to-end anastomosis, fourteen days. Marked diaphragm. Granulation tissue contracted down to a dense scar. Diaphragm entirely covered by newly formed atypical glands. Marked inequality in the amount of the intestine inverted on the two sides.

FIG. 12.



Gastroenterostomy, twenty-one days. Suture held together by dense fibrous tissue, except at the edges, which are covered on both sides with new mucous membrane.

FIG. 13.

End-to-end anastomosis of large intestine, six weeks. The scar is reduced to a thin fibrous line. Inner surface entirely covered with newly formed atypical mucous membrane, thick subserous scar formation (external callus).

the hole just occupied by the handle. The cut edges of the mesentery are caught together by a few interrupted stitches. (See Fig. 5.)

Lateral Intestinal and Gastrointestinal Anastomoses. The gather-stitch consists of two parallel arms crossing at one end. These arms are just wide enough apart to allow room for the incision. (See Fig. 6.) The mattress-stitch is omitted here and a continuous stitch is employed to approximate the serous coats and form the anastomosis.

Bleeding from the cut edges of the bowel is always controlled by tying the purse-strings, while one or two ties are usually necessary to control bleeding from the mesentery.

It is desirable to leave the ring in place after finishing the suture, because, although having no influence upon the process of repair, it serves as a splint while the adhesions are being formed. If it causes a decided stretching of the intestines, the ring should be broken down before closing the abdomen. This is easily and harmlessly done by gently squeezing the circumference of the ring through the intestine. After twenty-four hours the swelling of the inverted edges of the suture is great enough of itself to hold the ring in place without the catgut purse-strings. The rings examined after one to three days were much more firmly grasped by the suture than they were at the time of the operation. The swelling of the edges of the anastomosis subsides after four to six days, leaving the gut lumen and the purse strings stretched to a calibre considerably greater than that of the circumference of the ring. The ring accordingly collapses, although the catgut may not yet be disintegrated.

The passage of the segments through the intestines requires from one to three weeks. After gastroenterostomy some or all of the segments fall back into the stomach, and, if it is patent, pass through the pylorus. That the transit through the pylorus is slow is evidenced by Experiment 17, where three of the four segments were found in the act of passing through the pylorus fourteen days after operation. After end-to-end anastomoses one or two segments pass on together, while those remaining may lie in place at the suture for several days longer.

The suture material used for the mattress-stitch in the animal experiments was "No. 1" chromicized catgut, for the continuous stitch "No. 1" Pagenstecher's celloidin thread. No. 2 plain catgut was found most useful for purse-string sutures.

Details of Animal Experiments. A series of twenty-two experiments is reported below, in which fourteen dogs and four cats were used, as follows:

End-to-end intestinal anastomoses		8
Lateral intestinal anastomoses		3
Gastrointestinal anastomoses		7
		—18
Gastrogastrostomies		4
		22

End-to-end. (Dogs.)

Exp.	*Time elapsed after operation.*	*Condition of suture at autopsy.*	*Segments found.*
1.	1 day	Intact	At site of suture.
2.	1 day	Intact	At site of suture.
3.	3 days	Slough of suture, too large ring[1]	At site of suture
4.	7 days	Intact	Ileum.
5.	7 days	Intact	Two in ileum, two in rectum
6.	8 days	Intact	Ileum and rectum.
7.	14 days	Intact	Not found (passed).
8.	42 days	Intact	Not found (passed)

Lateral Intestinal. (Dogs.)

9.	5 days	Intact	Near suture.
10.	10 weeks	Still alive	
11.	4 weeks	Still alive	

Gastroenterostomies. (Dogs.)

12.	3 days	Intact	Three in pylorus (stomach), one in small
13.	7 days	Intact	Ileum. intestine.
14.	7 days	Intact	Ileum.
15.	10 days	Intact	Rectum.
16.	12 days	Intact	Large intestine and rectum.
17.	14 days	Intact	Three in large intestine and rectum.
18.	21 days	Intact	Not found (passed).

Gastrogastrostomies. (Cats.)

To determine how long ring remains in situ.

1.	24 hours	Intact	Segments held firmly in place.
2.	3 days	Intact	Segments held firmly in place.
3.	5 days	Intact	Segments still in place, loosely.
4.	6 days	Intact	Ring broken down, segments all in situ.

[1] The intestine in this case was so stretched over the ring that it was anæmic. As it was an early case, the importance of breaking down the ring under such circumstances was not recognized.

The Process of Repair. The close approximation of two serous surfaces which is characteristic of intestinal sutures results in a rapid exudation from the apposed surfaces. This exudation appears in a very few hours and hermetically seals the wound. Every coat of the bowel is soon penetrated by this exudate, rapidly destroying the epithelium on the outside of the bowel.

Repair of the Mucous Membrane. For the first few hours after the suture the mucous membrane is the seat of a marked active hyperæmia, with more or less bloody extravasation, the mucous edges being dark red and elevated from the coats below. This condition is followed by an exudation which extends into the glandular tissue until, at the end of three days, the glands disappear about the cut edge for 2 to 5 mm. When a large invagination has been made in the process of suture the submucosa becomes so swollen and œdematous that it probably interferes thereby with the circulation of the mucous membrane. Under such conditions the slough of the mucous membrane is correspondingly extensive. The amount of destruction of mucous membrane varies somewhat; but usually the slough is about 3 to 5 mm. in width. At the end of five days the slough generally separates, leaving a clean line. The above series of changes takes place in all sutures, although a separate suture of the mucous membrane seems distinctly to retard the repair. The reproduction of glands is more rapid in end-to-end than in lateral sutures. If the inturn has been a moderate one, the mucous membrane will cover in the ulcer in about eight days. The glands themselves, though atypical in shape, possess all the characteristics of mucous glands. At the end of eight days the line of sutures is represented by a narrow scar situated in the middle of what was formerly the ulcerated area. After gastroenterostomy and lateral intestinal sutures, the cleaning away of the slough takes place quickly; but the subsequent ingrowing of the mucous membrane is slow, since the interval to be crossed is a wide one. The process is exactly analogous to the healing of a superficial ulcer on the surface of the body. In these cases mitotic figures were seen at the end of five days, but were numerous only at the end

of ten days. The nuclear division, as a rule, first came in the mucosa of the stomach. On the tenth day a single line ofcells starts from the stomach and rapidly crosses the floor of the ulcer. The complete closing in of the bare area is much hindered by the presence of sutures, which, even though absorbed, leave irregular holes that are but slowly smoothed over. At the end of twenty-one days the line of suture is covered by a continuous though low mucous membrane. The line of demarcation between the stomach and intestinal glands is a sharp one, and is situated near the centre of the old ulcer. These glands, though atypically shaped, have normal functional power (goblet cells, etc.).

The new mucous membrane has no definite muscularis mucosæ. At first it rests upon a base of dense granulation tissue. This coat is very slow to repair; but at the end of six weeks a substitute muscularis mucosæ has been acquired, which consists largely of connective tissue, but in which are some fibres closely resembling smooth muscle. This layer has no sharp limits, and fades away into the scar tissue beneath.

Repair of the Serous Surfaces. The formation of plastic exudate does not cease with the resulting adhesion of the inturned serous coats, but appears externally for a distance of 3 to 5 cm. beyond the line of suture, thus acting like an external callus. The transformation of the exudate into granulation tissue is rapid. In three days a large number of new connective tissue cells have been laid down, among which are a few new bloodvessels that arise from the vessels in the underlying muscular coat. Entire organization of the inner exudate requires at least seven days, the outer at least ten days. After complete organization the connective tissue gradually disappears, finally remaining as a thick scar which reaches for a varying distance over the adjacent bowel and, dipping down into the depth of the suture, holds the bowel walls firmly together by thick strong bands. Fourteen days are required for the completion of this sequence.

Repair of Muscular Coats. The muscular coats play a passive role during the first forty-eight hours after the suture. The muscle bundles are penetrated by extravasated blood and

by exudate throughout their whole thickness. After the second day new bloodvessels bud out into the exudate and assist in its organization. When the inflammatory process has subsided the muscle ends are held together by scar tissue arising from the intermuscular connective tissue. This rapidly contracts and approximates the separated muscle ends, so that the ultimate scar is an extremely narrow one, and may be entirely unrecognizable by the naked eye.

Repair of the Submucosa. The loose texture of the submucosa allows easy entrance to the exudate. Almost at once this layer becomes distended and œdematous for several centimetres on either side of the wound. At the end of the inturned bowel this layer is often as thick as all the others combined. As organization proceeds the submucosa is filled with large and small bloodvessels and young connective-tissue cells which grow parallel to the surface of the bowel out into the exudate in the bottom of the ulcer, thus forming the base of the internal ulcer. Ultimately the ulcer is converted into scar tissue and is covered by an atypical mucous membrane. From comparison with a limited number of clinically successful intestinal anastomoses in human beings, it seems that the analogy of the process in these animal experiments and in human beings is a very close one, both in histological and in gross appearances.

Advantages of the Ring. 1. *Safety and Speed.* A complete resection and suture can be easily done in fifteen minutes and with as great safety as by any more protracted method.

2. *Cleanliness.* Assisted by the clamps, the purse-string sutures prevent even a mucous ooze while the continuous stitch is being placed.

3. An intestinal suture is more easily done over the ring than without it.

4. It is safe to use a single layer of continuous stitches, since the ring allows a perfect approximation to be made, and, afterward, protects the suture until adhesions have formed.

5. The handle is very useful for holding the intestines in convenient positions for sutures.

6. It is not necessary to sew up in layers, since the study of specimens from animals and human beings shows that the mucous membrane will slough in any case, and that repair is more rapid when the mucous membrane is not sutured.

7. The presence of the ring guarantees a free opening at the site of operation.

8. In case the continuous stitch should be improperly applied, the weak spots are protected by the ring itself for at least three days, until the ring breaks down. This allows strong adhesions to form.

9. After operation the ring holds the suture immovable and acts like a splint. The weights of the individual segments of the ring vary from 10 to 30 grains according to size. This is in marked contrast to most other appliances of a similar nature.

Disadvantages of the Ring. 1. General objections to mechanical contrivances.

2. General objections to one layer of sutures is hemorrhage or leakage.

3. Too large a ring may cause sloughing of the suture from pressure.

4. A foreign body in the intestine is always a source of some danger.

REPORT OF CLINICAL CASES.

Case.	*Diagnosis.*	*Operation.*	*Remarks.*
1.	Cancer of pylorus.	Anterior gastro-enterostomy.	Done at the Massachusetts General Hospital; recovery after operation.
2.	Cancer of pylorus.	Anterior gastro-enterostomy.	Done at Mass. Gen. Hosp.; death on tenth day from kink found at suture; suture intact at autopsy.
3.	Cancer of pylorus.	Posterior gastro-enterostomy.	Case of Dr. G. H. Gray, of Lynn; recovery from operation.
4.	Chronic pancreatitis with sinuses leading into colon and stomach.	Posterior gastro-enterostomy.	Done at Mass. Gen. Hosp.; death on seventh day from cachexia, though food was taken at once by mouth and digested; suture intact at autopsy; three pieces of ring in ileum, one had passed out.
5.	Uncontrollable vomiting of over two weeks' duration.	Posterior gastro-enterostomy.	Case of Dr. J. W. Spooner, of Hingham; stomach found contracted to size of intestine and displaced down to umbilicus; death in three days from uncontrollable vomiting; no autopsy permitted.
6.	Cancer of common duct.	Cholecystenterostomy.	Case of Dr. Philip Mooney, of Gloucester; recovery; lived several months.
7.	Irreducible intussusception in an infant.	Lateral anastomosis.	Done at Mass. Gen. Hosp.; death in a few hours; suture intact at autopsy.
8.	Intestinal obstruction from cancer of cæcum.	Lateral anastomosis.	Done at Mass. Gen. Hosp.; immediate feeding; rapid recovery; in good health after several months.
9.	Megacolon.	Resection, end-to-end anastomosis.	Done at Mass. Gen. Hosp.; immediate recovery; later abscess about suture (3 weeks), suture intact; abscess cavity healed by granulation; one segment passed by rectum three months after operation.

CONCLUSIONS.

1. The process of repair is as rapid after use of the segmented ring as after a plain suture.

2. The time required for the operation is, on the whole, less than that required for a straight intestinal suture.

3. Certain objections, such as weight, ulcer, difficulty of passage, etc., inherent in other mechanical contrivances are minimized by the ring.

4. The analogy between the experimental and the human observations is so close as to show the propriety of the deductions made from the animal experiments.

5. The employment of the ring in human beings is safe and satisfactory for all sutures.

Many thanks are due to Dr. E. H. Nichols, Director of the Surgical Laboratory of the Harvard Medical School, for valuable suggestions.

The drawings which accompany this article were made by Miss Florence Byrnes.

DISCUSSION.

Dr. J. W. Draper Maury, of New York City.

My excuse for asking the privilege of presenting this specimen is that it is the result of suggestions of two of the members of this Association—Dr. Theodore A. McGraw and Dr. Robert F. Weir.

Instead of using the elastic ligature at the Laboratory of Columbia University we have been employing twine. The specimen I have here was made with the elastic ligature, put in by a square knot, thus differing from Dr. McGraw's technique, but for the last three months we have obtained as good results by using simple twine instead of the elastic ligature.

The method of introducing the twine may follow the McGraw technique, although the triangular stitch possesses a very distinct advantage over it. This stitch "punches out" as much tissue as may have been included in the triangle. As to time, it cuts through in less than three and a half days. It must be very tightly tied. This is the sole requirement to success.

[Dr. Maury then demonstrated on a chart the technique of introducing the triangular stitch, and stated that he included about one-third the circumference of the gut in the stitch. The gastric triangle should, as a rule, be made larger than the intestinal.

He then passed around photographs of specimens made by this method, and a preparation from the gut of a pig, which demonstrated how free an anastomosis might be established. He also showed a number of circular bits of twine, which had been used in executing this technique. They had cut the triangle out and had been recovered after their passage through the rectum.]

Dr. A. J. Ochsner, of Chicago.

There is an actual prejudice against all mechanical means which I share with most surgeons, but at the same time the results which have been obtained without mechanical means are as yet not as safe and good as those secured with mechanical means. I will say in regard to the McGraw ligature that practically my best results have been obtained with it. I have used it eighty-seven times successfully, and the percentage has been better than my results have been either with the Murphy button, which I had used largely before, or with the needle and thread. An important point in connection with Dr. Harrington's method lies in the fact that it combines the advantages of the Mayo Robson bobbin and the intestinal holder, which was invented by Dr.

Lee, of Chicago. It has a very distinct advantage over suturing simply with needle and thread, because it leaves an open lumen. You are certain that when the operation is completed there is drainage between the two cavities. That is, of course, an advantage which the Mayo Robson bobbin and Murphy button have. It acts as a splint; it keeps the tissues where you have placed them. There is no sliding or sloughing. There is a distinct advantage in being able to hold the intestine by the handle of this contrivance, which it shares with the Lee contrivance, or the handle on Halsted's hammer. The surgeon can work more rapidly, with greater safety to the patient. The amount of time the patient is under anæsthesia is very little, and danger comes very largely from the unnecessary things that are done during that time. If one has his work before him, and the parts packed away from the remaining portion of the abdominal cavity, he cannot do a lot of mischief. Furthermore, one great advantage of the McGraw ligature is that you have your work where you do not disturb anything else in the abdominal cavity, and after you have completed the operation the small amount of traumatism caused during the operation has done the patient no harm. In suturing one is likely to do unnecessary mischief in the peritoneal cavity, and is likely to increase the mortality on that account. The fact is that intestinal surgery, when one does it without trying to do anything more than is absolutely necessary, is very simple, and I believe that Dr. Harrington's contrivance will tend to simplify this work, and in that way reduce the mortality.

As regards the gastroenterostomy opening, which one can obtain with the largest-sized ring which Dr. Harrington has shown us, it is too small. Unless there is excision of the pylorus one will probably get a contraction of the gastroenterostomy opening precisely the same as one does with the Murphy button in over 75 per cent. of the cases; so that, for a gastroenterostomy without excision of the pylorus for ulcer or for partial contraction of the pylorus, I am certain that this device will be a failure unless its size is increased.

Dr. Harrington. The point which Dr. Ochsner has just made is an important one. If the pyloric opening is patent a gastrojejunostomy of large size may close. The ring which ordinarily should be used in gastrojejunostomy has a circumference of a little less than three inches. This would give a linear opening of a little less than one and one-half inches. If the next larger ring be used the linear opening would be one and three-quarter inches. The actual incisions for inserting the rings into the stomach and intestines would be larger than this. The puckering string makes it possible to make the incision much longer.

With a large incision by the ordinary methods of gastroenterostomy it is found, the pylorus being patent, that there is a tendency for the gastroenterostomy opening to close. This has become so troublesome that closure of a patent pylorus is advocated. If the pylorus is closed, the opening made by the ring will be ample. If too large a ring is used, either in end-to-end or lateral anastomosis, the tissues might be so pressed upon that sloughing would follow, but with ordinary care there is no danger of such a result.

THE TREATMENT OF CONGENITAL CLEFT PALATE.

A PLEA FOR OPERATIONS IN EARLY INFANCY.

By TRUMAN W. BROPHY, M.D., D.D.S.,
CHICAGO, ILL.

Mr. President and Gentlemen of the American Surgical Association:

I desire to express to you my appreciation of the honor of the invitation extended me to be with you and present a communication on what I believe to be the advantage of operating in early infancy for the correction of the deformity of congenital cleft-palate.

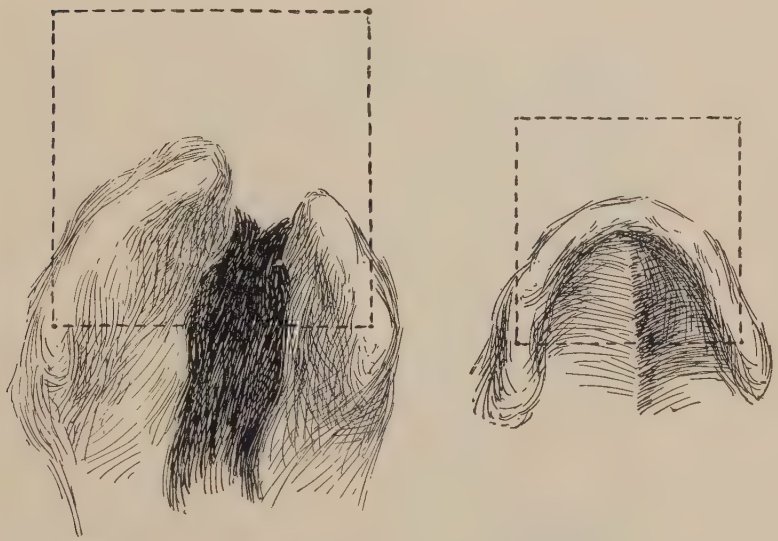
Since La Monier, the Frenchman, in 1764, declared that this deformity was amenable to successful surgical treatment the question as to the most desirable age for operating has received a great deal of attention.

In an article by Dr. Kirmisson, of Paris, chief surgeon of the Trousseau Hospital and Corresponding Member of the American Orthopedic Association, on "Congenital Cleft Palate" (which has been translated from French into German by Karl Deutschlaender, assistant to the Royal Surgical Clinic of Greifswald, and which article composes a chapter of Deutschlaender's work on *Congenital Deformities*), Dr. Kirmisson enters into a description of defects of the palate in a most thorough and complete manner.

As to the most desirable age for operating, Professor Kirmisson states: "Before the employment of chloroform the operation was necessarily delayed until the child became old enough to under-

stand the operator's instructions. Thus, Roux put the age at sixteen years, Augenback and Trelat operated at seven years. At the French Surgical Congress in 1889 Ehrmann reported his results of early operations. He operated upon ten children under two years of age with six good results, two deaths, and two failures. Twenty children between the ages of two and six months under-

FIG. 1.



Drawings from careful measurements of casts from life, showing relative positions of upper and lower jaws in the case of cleft palate in a young child. (The print is life size.) The dotted squares are made in exact proportion to the width of the respective alveolar processes at corresponding points. The large square is the width of the cleft greater than the smaller square. When the cleft is closed the squares will be of equal size, and consequently the teeth will occlude normally.

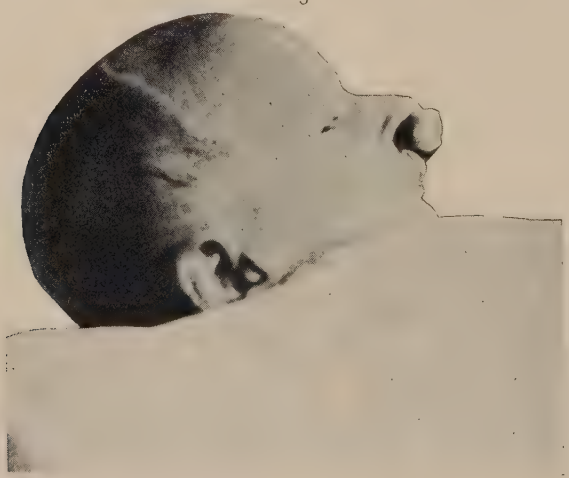
went operations, with seventeen good results and two deaths and one failure; lastly, eleven operations between the ages of seven and ten years, showing ten good results with one failure." These results, says Kirmisson, speak against operations performed during the years of early childhood. Professor Kirmisson further says: "J. Wolf, of Berlin, recommends early interference and unhesitatingly operates on children of from one to two years.

I have not had an opportunity to see Wolf operate. I must confess, however, that notwithstanding his excellent operative

FIG. 2.

Photograph of an infant's mouth eight weeks old, showing cleft palate, bilateral harelip, and protruding premaxillary bones. The vomer is not attached to either side.

FIG. 3.



Profile view of same child, showing extent of protrusion of the premaxillary bones.

technique and the employment of his tampon, operating at this early age strikes me as difficult and dangerous. The field for operating is too small, the tissues thin, the sutures therefore easily cut through." This statement by Professor Kirmisson is an argument in favor of postponing the operation on the lip so as to enable us to get the benefit of extra room which the labial opening affords us. Further, he says: "There exists the danger of severe hemor-

FIG. 4.

Palatal surface of mouth of child five weeks of age, showing extensive cleft of the hard and soft palate and unilateral harelip.

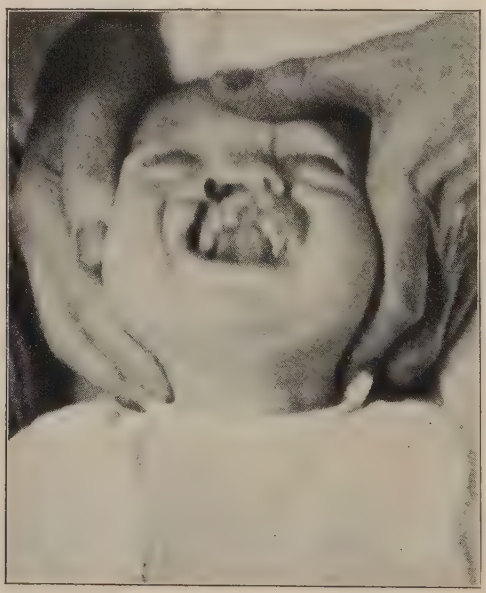
rhage; and, lastly, it is almost impossible to successfully follow antiseptic asepsis. Therefore, I strongly recommend operating between the fifth and sixth year." Lawson Tait, however, states: "The mortality of children who have congenital cleft palate is so great by reason of their failure to secure proper nutrition, that an early operation would seem desirable."

Our text-books and professors of surgery, with few exceptions,

teach that congenital harelip should be operated on in early infancy, and that no attempt should be made to close the cleft of the palate until the child is several years old.

The practice and teachings of surgeons of highest repute has led medical men, quite generally, to advise those who seek information as to the most desirable time to operate for hare-lip and cleft palate, to have the lip operation performed at once and to

Fig. 5.



Palatal surface of same mouth one week after the operation for closure of cleft of the hard palate.

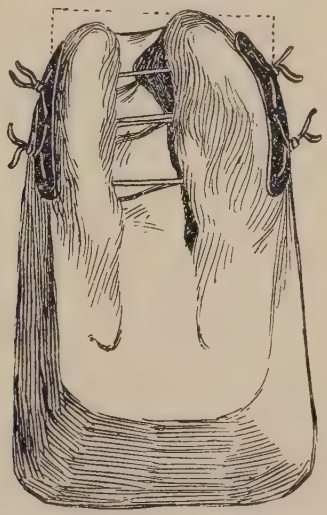
postpone the palate operation until the child is from three to ten years old.

Having studied carefully the literature of the subject and the methods pursued by other operators I have endeavored not only to overcome the objections raised to early operations, but also to avoid difficulties with which the older surgeons contended. After many years of study and clinical experience I am satisfied that

the most desirable time for operating on cleft palate is within three months after birth. By operating at that time we are able to secure more satisfactory results than in later life, and we also avoid the objections usually raised by surgical writers.

As just remarked, I believe in operating within three months after birth, if practicable, and this belief has been more and more justified by my experience of twenty years in operations performed for the closure of cleft palate on patients from ten days to fifty-two years of age, including nine hundred and twenty-seven operations.

FIG. 6.



Drawing of a plaster cast of the mouth of the child represented in Fig. 4, showing lead plates and wire sutures in place.

The late Professor Garrettson, of Philadelphia, expressed the views of most authors on this subject when he said: "In looking over the history of staphylorrhaphy the reader will be struck with the likeness in complaints, the three principal of which seem to be the difficulties in tying the sutures, their great tendency to cut out after they are once nicely secured, and the concealment of the parts during the operation both because of deficiency in light and the accumulation of the viscid mucosaliva which in

mouths thus affected is secreted in great abundance." Further, he states: "As generally practised it is rather difficult of performance and so frequently unsuccessful that surgeons seem disposed to avoid the responsibility of it."

In addition to the complaints above enumerated, hemorrhage has been regarded as a serious complication during the operation.

If we can devise a plan of procedure by which all the objections named can be to a great extent overcome, we shall have made an important advance. *This advance has been made.* How has it been accomplished?

FIG. 7.

Drawing of a cast of the same mouth (Fig. 5) one week after cleft was closed.

In working out my method of procedure I have *reversed the sequence* of the operation, making that upon the palate first in order.

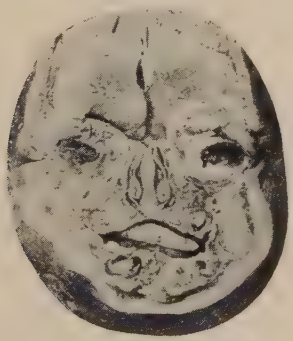
That we may have access to the mouth and that we may have sufficient light reflected on the *locus operandi*, we make use of the oral speculum. This instrument not only remains in place during the operation, but it illuminates the mouth, it presses the lips and cheeks back, and depresses and holds the tongue. I

may add, by the way, that the oral speculum is of great value to the laryngologist. By the use of this instrument we command a most satisfactory view of the field of the operation, and we have no difficulty in "tying the sutures."

FIG. 8.

Section of head of infant cadaver, showing cleft palate, extreme breadth of upper jaw, and abnormally broad nasal passage.

FIG. 9.



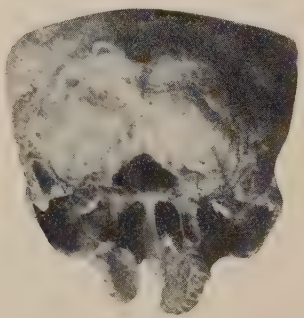
Section of head of infant cadaver having normal palate. The upper jaw shows correct relations to the lower one, and the nasal passage is of proper breadth.

The sutures cannot "cut out" if lead plates are used in the manner here indicated. If hemorrhage occurs, it is due to the lateral incisions, which divide, if not the palatine artery, the palatal branches given off from it, which dilate under the pressure of the blood, inducing this troublesome hemorrhage.

I cannot too strongly discountenance the making of these lateral incisions along the surface of the palate in infants, older children, or adults. The incisions are not only unnecessary for the relief of the tension, but they are a positive detriment. The great mortality following palatal operations in children has, I believe, been caused more by weakened conditions due to these incisions followed by loss of blood than by all other causes.

We reduce hemorrhage to a minimum because we divide no vessels. Capillary hemorrhage is checked by the use of hot tampons; or, if need be, 1: 10,000 adrenalin chloride applied to the bleeding surface.

Fig. 10.

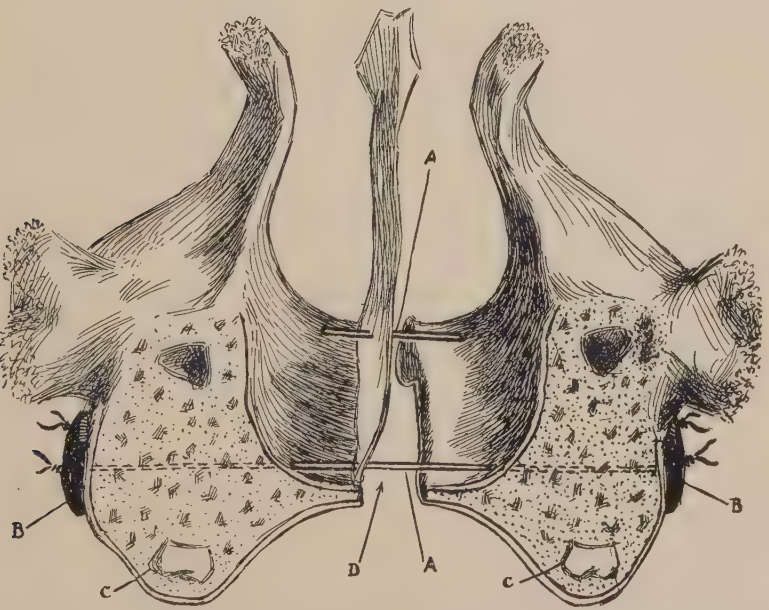


Photograph of adult's skull, showing cleft of the hard palate. There is no absence of bony tissue. If the bones were forced together the hard palate would be perfect.

Children having congenital cleft palates are usually not lacking in tissue for forming a normal palate, but the upper jaw in such deformities is broader than the lower; the difference in the breadth of the upper jaw as compared with the lower, with few exceptions, being the distance between the borders of the cleft. (Fig. 1.) The theory, so long and generally accepted, that congenital cleft palate is due to an insufficiency of tissue which enters into the formation of the palate, is erroneous. There is an abundance of tissue, in nearly all cases, to form a perfect palate, but, unfortunately, during the development of the child in embryo the edges of the bone fail to unite. (Figs. 2 to 7.) The bones of the upper jaw having failed to unite prior to the

sixth month of intrauterine life, the lower jaw, as soon as the muscles of mastication become active, brings pressure upon the palatoalveolar inclined plane of the upper jaw, and, acting as a wedge, forces the hemispheres of the separated upper jaw farther and farther apart. The pressure of the lower jaw therefore widens the breach, but if we are able to bring the edges of the tissue into contact and effect a union while the bones are soft and

FIG. 11.



Vertical section of the superior maxillary bones of a child five weeks of age, showing congenital cleft palate. A, A. Silver tension sutures. B, B. Lead plates. C, C. Germs of the first temporary molar teeth. D. Cleft palate.

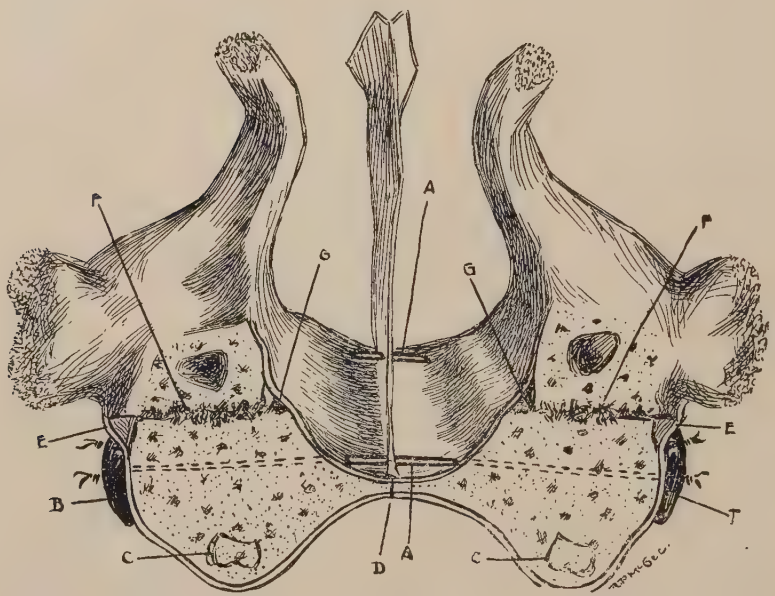
flexible we may reduce the upper jaw to its proper breadth, and so bring it into normal relation to the lower jaw. (Figs. 8 to 14.)

It has been observed that the contraction of the orbicularis oris muscle after the harelip has been closed will sometimes approximate the anterior alveolar border of the maxillary bones, but this does not correct the palatal defect nor reduce the breadth of the fissure in its distal part.

Among the advantages I give in favor of early operations are the following:

1. The surgical shock is less in the case of an infant than in the case of an older person. The nervous system of a young child is not well developed, and it is not, therefore, capable of

FIG. 12.



Vertical section of the superior maxillary bones of a child five weeks of age, showing method of closing cleft of hard palate. A, A. Silver tension sutures. B, B. Lead plates. C, C. Germs of first temporary molar teeth. D. Cleft closed. E, E. Mucoperiosteum, forming extended wall of the triangular space by forcing the lower fragments of the bone inward. F, F. Lines of fracture made by approximation of the palatal process. G, G. Triangular space on nasal surface of bone made by approximation of the palatal process.

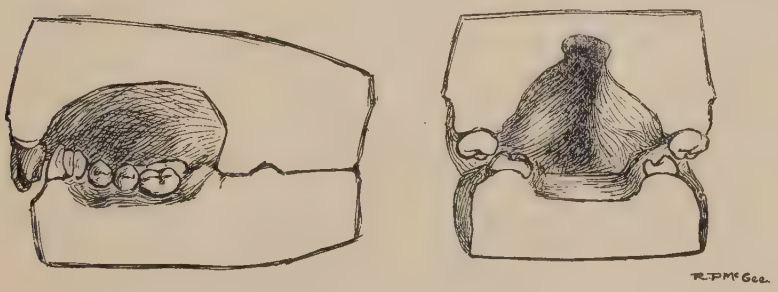
receiving the same impressions that it would late in life; besides, young children usually react better. Moreover, the element of mental apprehension is absent, and we know that alarm and dread are among the most powerful factors in producing nervous shock.

2. Before the bones are fully calcified they may be bent or moved without fracture. Bone at birth is about one-half organic

matter; hence the injury is really less in closing the cleft than it would be if calcification were more nearly complete.

3. If the muscles are very early brought into action they develop instead of atrophy, and hence a good velum is secured with plenty of tissue; whereas, if the operation is undertaken later in life, the parts are undeveloped through non-use, and they cannot so easily be made to subserve the same purpose that tissues which develop through natural employment can be made to do. It is well known that muscular tissue is more perfectly developed through action. In instances of cleft palate, none of the muscles of the velum can be normally employed when the parts are not united, and hence they remain in an immature condition through

FIG. 13.



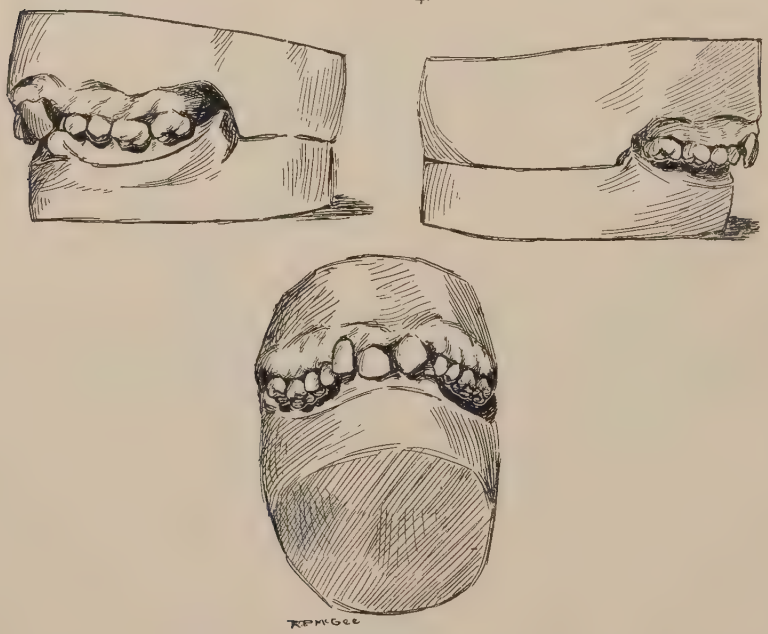
life, even when an artificial substitute is inserted. By operating at a very early age they are brought into use, and their use is proportioned to that of other tissues.

4. As a consequence of early operation there is much less deformity than in the case of a later operation, as all the tissues, bony as well as soft, are thus enabled to develop naturally and according to accepted types.

When the palatal processes of the maxillæ are united it will be observed that the bones in the development of the alveolar process of the upper jaw assume a form nearly or quite normal, and when the teeth are erupted they will properly occlude with the lower ones or nearly so. In my first case the breadth of the jaw was reduced about three-fourths of an inch. It was predicted

by my surgical friends that the upper jaw would be much narrower than the lower one, and that it would always remain contracted. Clinical experience and observation, however, have shown that this prediction was not well founded. We restore in *early infancy* the normal relations of the superior maxillary bones by forcing them together and holding them there until they unite. In patients

FIG. 14.



Cuts made from plaster casts. The upper teeth as shown by Figs. 13 and 14 lap over the lower ones. Had this patient been operated upon in early infancy the upper jaw would have been made the normal width, and the occlusion of the teeth would be correct.

not having sufficient bony tissue to enable me to close the cleft by this operation without contracting the arch, I found, rather to my surprise, that as time went on the bones developed and the arch spread until, when the upper teeth were erupted, they occupied nearly or quite the normal relation to the lower ones.

The most beneficial result of the early operation is that it permits the normal development of the speech function.

Notwithstanding the fact that the surgical operation on an older child or an adult may produce a palate perfect in all its anatomical parts, the patient's faulty habits of speech will have become so fixed that special training in phonation will be required to overcome the speech defect. In all such cases of deferred operation, the patient should be placed as soon as practicable after the operation under the instruction and care of a speech specialist.

In conclusion, it may be wise to point out the fallacy of operating on the harelip before closing the palate, and to show the logic of reversing the sequence.

In cases of complete cleft of the hard palate accompanied by harelip, either single or double, *the lip must not be first operated upon.* We cannot close the cleft of the bones by transfixing them and secure immediate union after the lip fissure is closed.

The harelip, as a rule, has been operated upon before closing the palate, because the deformity is so conspicuous and distressing to the parents that surgeons close it in order to relieve this embarrassment, and then three or four years later operate on the palate. Such a procedure is parallel to half closing a door and then attempting to carry a piano through it. We need the open door because we have a great deal to pass through it. We need for the transfixing of the bones all the space the open lip affords. The lip, therefore, *should not be closed in infants until the bones of the palate are first united.* From two to three months after the bones are united, if the tissues of the soft palate are thin, and it seems desirable to wait a few months longer for them to become stronger and thicker, the lip may be operated on, as its closure does not then materially interfere with the work on the soft palate.

You will see that I have attempted in the foregoing to give merely an idea of what I consider to be the advantages of early infancy operations for this deformity, etc. As my book on *Malformations, Diseases, and Deformities of the Oral Cavity, with its Surgical Treatment,* will soon be published, I have here confined myself exclusively to a mere statement of the advantages and results and have omitted the details of the method.

DISCUSSION.

Dr. J. Ewing Mears, of Philadelphia.

When I had the pleasure of meeting Dr. Brophy this morning, after the lapse of many years, he recalled the fact that, as a student, he had been under my instruction, and that I had shown him the first operation for cleft palate he had witnessed. Whether that instruction is the result of what you see to-day in the cases he has presented for our examination I cannot say. It may have been a suggestion, and directed him into this field of work. Whatever the influence exerted at that time I have much pleasure in saying that I have been greatly interested in examining patients he has brought before the Association, and I congratulate him upon the results he has obtained under his method of operation. With his method I am familiar, and while it accomplishes that which is the object of all methods of operation upon the palate—closure, more or less readily, of the cleft—it has been a question with me whether it is as free from danger as other methods, and, also, whether it does not produce conditions, such as permanent contraction of the upper jaw, which are productive of disability in the use of the jaws. If we accept the opinion that the gap is the result of defective nutrition, accompanied by a positive loss of structure, then it would appear necessary, in order to avoid permanent contraction, that development and growth, sufficient to replace the wanting structure should occur, after apposition and union of the edges of the cleft. Experience in a large number of cases of operation and opportunity to examine them after a number of years, up to the time when bone development and growth terminate, will permit correct conclusions to be arrived at upon this question.

I have been interested in this subject for many years, and, inspired by the desire to relieve the unsightly deformity present in complete cases, and to remove, so far as possible, the distressing disability which accompanies all forms, I have performed many operations. In my study of the subject my attention has been directed especially to the etiology, in the hope that some positive results might be obtained in the way of prevention. During a visit to Dublin some years since I gained some important information upon the subject from the professor of anatomy in Trinity College, who, as a member of the Board of Directors of the Zoological Garden, had had the opportunity to study the condition in the whelps of lions born in the garden. The mortality among these was very great, owing to the occurrence of cleft of the palate, which prevented the taking of sufficient nourishment from the mother to maintain life. With a view to prevent the occurrence of this

condition, under the advice of the professor, bone-producing food was given largely to the mothers during gestation, and, as the result of this method of feeding, he informed me that the condition had disappeared and the garden was successful in rearing a large number of lions, which became a very productive source of revenue by reason of the sales which were made. The observations made in these cases would seem to justify the conclusion that in cleft of the bone the question of proper nutrition had an important influence, and that in all cases of gestation, and especially in women the members of a family in which this condition had occurred, careful attention should be given by the family physician to the administration of bone-producing food.

As to the results to be obtained by operation—no matter what method may be employed—my experience leads me to the conclusion that it is not possible in every case to secure perfect articulation. In some cases the success in this direction is very marked and gratifying, and this, according to my observation, is due to the favorable conditions existing in the size and conformation of the pharynx. Where this is small and facilitates by this condition the complete approximation of the restored soft palate to its posterior wall under muscular action, thus preventing the passage of sounds into the nasal cavities, operation at an early period of life will conduce, in a measure, to favorable conditions in these cavities, and therefore should be advocated. In cases of capacious pharyngeal cavities with defective muscular action, the restored palate, deficient as it is in structure, is unable to completely close the posterior nares, and defective articulation is the inevitable result.

I have placed patients after operation in schools of voice culture, and have found in some instances that favorable results have followed instruction of this kind.

Although I have operated upon patients from the age of three to fifty years, I am strongly in favor of operation at early periods of life, for the reason that all of the disabling and defective conditions are more likely to be relieved. Defective deglutition is certain of positive relief, defective articulation of probable relief, and the moral effect exerted upon the growing child in its association with its companions is most beneficial in contributing to happy conditions of life.

The subject is one of importance, and should command the earnest study and efforts of the surgeon.

Dr. Alexander Hugh Ferguson, of Chicago.

I am pleased to have heard Dr. Brophy describe his method of operating on cleft palate. I agree with him as to the age for operating. I am

convinced that all operative procedures should be completed before the child begins to talk. I presume that while Dr. Brophy has referred somewhat to the literature he does not pretend to give it fully. American literature is quite replete on this branch of surgery.

I rather take the view that it is not necessary to perform so formidable an operation as the crushing of the two superior maxillæ together in order to close a cleft palate. I prefer to perform the flap-formation operations which I have already published. Dr. Brophy's condemnation of the curvilinear incisions on account of hemorrhage is not supported by my experience. If a surgeon knows how to use the knife followed with finger pressure and then with a packing of iodoform gauze into the wounds made, the mucoperiosteal flaps can be raised with practically no hemorrhage.

The only two patients of cleft palate that I have lost were operated on after Brophy's method. They were under three months of age, and they died from shock. I consider the crushing of the maxillæ together a major operation in the case of an infant, and surgical experience bears out the fact that infants readily succumb to major operations.

If a plastic operation is properly performed on a cleft palate there is very little danger of sepsis taking place. When the flaps are neatly formed and properly sutured so as to have a ridge on the nasal aspect, a broad raw surface for coaptation, and mucoperiosteal flaps nicely brought together, there is very little danger of mucopus finding its way from the nose as to seriously infect the wound. Both the immediate and remote results are perfect in uranostaphylorrhaphy performed within the physiological age—that is, before the child begins to speak. It is exceedingly rare to have failure in union or in phonation. If, however, the child is operated on after this age it is advisable for it to forget its mother tongue and learn some other language, in order to improve the phonation.

I should like to draw your attention to the fact that the upper jaws are normally broader than the lower, and when the crushing operation is performed marked irregularity of the teeth occurs, which was evidenced by the cases presented here to-day. By the plastic operation there is no such irregularity of the teeth, and mastication is not interfered with.

Dr. Brophy's experience of 927 operations for congenital defects on the lips, hard and soft palate, is more extensive than most of us has enjoyed, and I would like to ask the doctor to tell us in his closing remarks what his mortality has been in infants after crushing the two maxillæ together.

Dr. George Tully Vaughan, of Washington, D. C.

Personally I wish to thank Dr. Brophy for having heard his interesting paper. I have been teaching his method of operating on cases of cleft palate for seven years, and I would like to have seen him do the operation. There is no question in my mind but that it is the proper operation for cleft of the hard palate, and that it is based on scientific principles and gives excellent results. I know very little about the mortality of these cases, but those I am familiar with and know of have had no mortality. Dr. Brophy has a right to feel that he has conferred a benefit on mankind in having devised this operation.

Dr. Brophy. I am very glad to be here to-day, and I am pleased to meet my teacher, Prof. Mears, under whose guidance I began work in surgery of the oral cavity. As I remarked to Prof. Mears, I never saw but two operations performed for closure of cleft palate: one by himself and one by the late Dr. Charles T. Parkes, of Chicago.

With reference to Dr. Ferguson's remarks, with regard to the literature of the subject, it is true that no one more keenly appreciates than I the richness of the literature on palate defect. It was impossible, however, for me, in the brief period of fifteen minutes, to indulge in anything like a review of the literature on the subject. I know that Prof. Ferguson has written extensively on this subject himself, and that very valuable articles have appeared from his pen, which I have read with great interest and profit.

I cannot agree, however, with the method he has described of bringing the palatal plates of the maxillary bones together instead of bringing the whole substance of the bones together. If I had upon the screen again a picture of the bones of the jaw given me by Prof. Binnie, I would show you that by bringing the hard palate together, after dividing the bones between the fissure and the alveolar processes, it would not correct the deformity; it would not bring the maxillary bones in proper relation to each other so as to get natural occlusion of the teeth. We must put the bones together the way nature intended they should be. and we must approximate them in the manner in which nature intended they should be approximated.

I do not see the necessity of the use of the lateral incisions advocated by Sir William Ferguson, Prof. Agnew, and Dr. Alexander Hugh Ferguson, and others. I see no reason why in operations upon the palates of adults those incisions should be made. If we divide the mucoperiosteum as it extends over the palatal plates of the bones—that is, cutting off the nasal mucoperiosteum—then the whole palate will drop and elongate, so that we can produce a good result. There will be no ten-

sion. There is no necessity, in my opinion, in such cases, of making these lateral incisions, which are an absolute detriment to the patient, because you put out of use an important muscle, the tensor palati muscle, which has a double function. As a result of the complete division of that muscle we have in most cases not only a mass of cicatricial tissue which makes a clumsy palate, but we have defective hearing by reason of the failure of the Eustachian tube to open normally.

As to the mortality, in these young children it is not high. I have not lost 3 per cent. of the cases upon which I have operated by this method, and in almost all of the cases it was an easy matter to consider other conditions and complications. In some of the cases complications might have occurred if the children had not been operated upon. I place the mortality at 3 per cent. in 300 operations on infants, and I regard that as a very good record.

I have nothing more to say on this subject except what I have said in my paper, namely, to urge operations upon the palates first. It is a distressing thing to me to have a child brought to my office five months old for the purpose of having an operation done, and find that its lip has been closed. We want the bones closed; we want to get a bony palate, and we can do that best by carrying the bones over when soft, and if they were carried over the next day after birth in some instances it would be an advantage, because then one may take the thumb and finger, make pressure on the bone, and in some instances see the edges come in direct contact. We want to freshen them and hold them there. Permit me to cite one of my experiences in early manhood. In visiting New York after leaving Philadelphia I saw a surgical clinic conducted by the late Lewis A. Sayre, a distinguished orthopedic surgeon. He brought a child into his clinic who had a double harelip and cleft palate. He took it up and held it before the class, saying: "Gentlemen, you see I am able by pressure with thumb and finger to almost approximate the edges of the cleft palate. If we had some plan by which we could bring the tissues in contact and hold them there until nature united them we would be able to cure this defect. But we cannot do it." I did not forget that remark of Prof. Sayre, and eight years later I devised a plan by which this could be done.

THE EVOLUTION OF SURGERY.

By J. EWING MEARS, M.D.,
PHILADELPHIA.

The occasion would seem to be fitting, when our Association holds its annual meeting in the metropolis of a State which illustrates, in its marvellous development and substantial growth, the greatness of that vast territory, the cession of which, to our country by purchase a century ago, is in process of elaborate commemoration in most impressive manner and in colossal proportions, to direct brief attention to the process of unfolding which has attended the science of surgery—its evolution from that which it *was* in the earliest beginnings to that which it *is* in the present day. I have ventured to employ the term "evolution" as representing "an orderly succession of events or a process of becoming," indicating a progress from the lower to the higher—"the substitution of the complex for the simple type."

In such etymological sense "that which evolves must contain in some shape what is evolved," and thus we find that the art of surgery is as "old as human needs," and found its beginnings in the primitive conditions of life which attended the savage state, when wars and conflicts prevailed and wounds and injuries required treatment. In this manner there was developed skill in the control of hemorrhage, in the extraction of missiles, in the adjustment and support of broken bones, and, in general, in the dressing and care of wounds. Observation and experience gave knowledge with regard to the healing power of tissues, and then, as now, confidence—more or less assured—was reposed in the results to be attained under the methods of treatment employed.

For convenient study I have chosen to divide this unfolding of surgery into three periods of time:

First. That which extended from the beginning to the time of Ambroise Paré (1517–1590), the father of French surgery, as he has been designated, who introduced the use of the ligature in large operations. Second. The use by John Collins Warren, in 1846, of ether as an anæsthetic agent in surgical operations, and, lastly, the discovery and introduction into general use by Joseph Lister (1860–1875) of the antiseptic treatment of wounds.

The occurrence of these events marks three great epochs in the history of surgery and has influenced its development and progress, not only in operative procedures, but in the enunciation of the great principles upon which the science rests.

Reference to the definition of the word "surgery," as that branch of medicine which treats of "manual operations for the healing of diseases or injuries of the body," will explain the character of the work done by those who devoted themselves to this branch of the healing art in the beginning, which constituted the ancient surgery of the *Hindus*, and will account for the development of the art along the lines of mechanic invention and practice, in the designing and manufacture of numerous instruments, more than one hundred in number, most, if not all, of which are in use to-day. Surgical operations of importance and great gravity, it is recorded, were undertaken, including lithotomy, without the use of the staff; varieties of hernia treated by operative methods; abdominal section for intestinal obstruction, with removal of concretions; suture of the intestinal wound and return of the bowel to the abdominal cavity; Cæsarean section; amputations, boiling oil and pitch, with pressure by bandage, employed to control hemorrhage; extraction of cataract; magnets used to remove iron particles from wounds; plastic operations for restoration of the nose; dislocations and fractures classified, and differential diagnosis elaborated; inflammations treated by venesection and antiphlogistic remedies, cupping, poultices, etc.; constitutional treatment instituted in surgical cases, and medication employed.

Instruction in surgical practice was given by physician priests;

knowledge gathered from books was esteemed of little value without experience and manual skill in operative work; ingenious devices were employed in demonstrations; wax spread on boards was used to illustrate surgical operations; gourds, cucumbers, and other soft fruits to show method of incisions; puncture and tapping demonstrated upon stalks of water lilies, and leather bags filled with water or soft mud; bandaging was taught on flexible models of the human body; live animals used to show the effects of caustics and cauterants, the first example of vivisection. Anatomical knowledge was regarded as necessary, but was not taught in a systematic manner by dissections.

The *Sušruta* contained minute directions as to surgical practice. The ignorant were impressed by superstitious ideas, and teaching was given out as a revelation from Heaven and dependent upon absolute authority. Pathological principles were based upon a "conventional physiology—three humors, wind, phlegm, and bile"—and it has been well stated that the "whole fabric of instruction, good though its utility must have been for many generations, was without the quickening power of reason and freedom, and became inevitably decrepit."

Specialism did not exist in the profession; there were no fixed degrees, and there was no distinction between practitioners of medicine and surgery. In capital operations, as lithotomy, the permission of the Rajah was required; caste regulated to a certain degree the practice of medicine, and "the only distinction recognized between medicine and surgery was in the inferior order of barbers, nail-trimmers, ear-borers, tooth-drawers, and bleeders who were outside of the Brahmanical caste."

In the process of unfolding it will be convenient to note the growth along the lines established in the beginning: perfection in operative procedure and elaboration of technique, the development in teaching and authorship, the gradual ingrafting of the science, and the distinctive impression made by individual attainment.

In chronological and racial order the records show that among the *Chinese* surgery was rudimentary in the largest degree. This condition was due, in certain regard, to the "unwillingness to

draw blood and the respect entertained for the dead body." The insertion of fine needles of gold or silver—acupuncture—was the only distinctive operation practised, which was done for the relief of pain or inflammation, the needles remaining in the tissues for several minutes or days.

The inscriptions and drawings on *Egyptian* monuments and on the walls of temples illustrate the degree of development of surgical practice among these people. These show the application of bandages and the performance of operations upon patients. In the ancient tombs surgical appliances have been found, and in mummies, artificial teeth. The country is described by Herodotus as full of medical practitioners. Among these, ophthalmic surgeons were especially numerous and distinguished, owing, possibly, to the prevalence, in such marked extent, of ophthalmia.

The "Hippocratic Collection" gives, in the highest degree, character and distinction to surgery among the *Greeks*. As described by Homer, surgery was that of the battlefield, and limited. In the "Hippocratic Collection" the treatises on fractures, dislocations, wounds, and injuries, especially those of the head, are most complete models in descriptive precision, giving evidence of original investigation, of accurate observation, of knowledge and skill gathered in fields of wide experience, illustrating methods of practice which exhibit fertility of resource similar to that which gave character to *Hindu* practice. The recognition of tuberculosis as an etiological factor in spinal curvature was among the most noted achievements of diagnostic skill, and anticipated the labors of Potts in this direction, although it has not disturbed modern nomenclature. Empyema was diagnosed and treated by intercostal incision, with evacuation of the pus, and lithotomy was practised by experts. The art of surgery, as with that of sculpture, did not receive any assistance from dissections, which were not practised, but owed much of its excellence to the opportunities offered for study of the human frame in the "Palæstra" or the place of wrestling.

From the Hippocratic era to the founding of the school of Alexandria (about 300 B. C.) but little progress was made in

surgery. The cultivation of human anatomy, inspired by the instruction of Herophilus and Erasistratus, the first anatomists who dissected and described parts of the human body, gave distinctive character to this epoch in the development of diagnostic precision and boldness in operative procedure. Even the internal organs, the liver and the spleen, were fearlessly attacked by the knife in the hands of Herophilus. Ammonius was the first to introduce the method of crushing with instruments large calculi, and in this way facilitating their removal, by incision, from the bladder. He also treated retention of urine by the use of the catheter. Neatness in bandaging and diversity in dressings were characteristic features of practice by the surgeons of the Alexandrian school.

The *Arabian* contribution to surgery was very small; the work of the ancient world was simply preserved intact. The study of anatomy was proscribed by their religion, and it was characteristic of their race to accept sufferings which came to them and to decline means of relief.

In the time from the reign of Augustus (25 B. C.) to the *Middle Ages* three men lived, who by their work made a lasting impression upon surgery—Celsus, Galen, and Paulus, of Egina. As the authors of voluminous treatises they, as has been truly stated, "brought the whole surgery of the ancient world to a focus." Among the important operations described and discussed are those for hernia, with the recommendation that the actual cautery should be applied to the canal after reduction; resection of the ribs; operations upon the thoracic cavity; subcutaneous urethrotomy; amputation of the extremities, with torsion and use of actual cautery to arrest hemorrhage; resection of bones and of the upper jaws; tenotomy, and, most notably, the brilliant operation of Antyllus, pronounced at that time one of the greatest of the world's surgeons, for aneurysm, ligature of the artery above and below the sac, with the evacuation of its contents.

The event which most distinctly influenced surgical progress in the *Middle Ages* was the founding of medical schools in which systematic instruction in surgery was given. One of the first

among these which became famous was that at Salerno; then the Hotel Dieu at Lyons and Paris; the school of Montpellier; the Universities of Bologna and Naples; the College of Surgeons of Paris, which became the models for schools organized in London and Edinburgh.

Coming to the *fourteenth* and *fifteenth* centuries surgery received a new impulse in two men of originality and genius—Paracelsus (Theophrastus Bombast von Hohenheim) and Ambroise Paré. The teaching of the former has been regarded as having merit "clouded as it was by mystical forms in which it was cast." His writings had value, the most important among them being those on "Hospital Gangrene," which is described as "true to nature," and the healing of wounds.

Ambroise Paré, called the father of French surgery, began life as an apprentice to a barber surgeon in Paris, afterward becoming a pupil in the Hotel Dieu. Entering the army at an early age, he availed himself of the opportunities to study military surgery, and made valuable contributions to this special branch; among the most important of which were those on the character and treatment of gunshot wounds, maintaining that they were simple *contused* and not *poisonous* wounds, and should be treated by simple methods, and second, and most valuable, were the efforts he made, which were crowned with final success, to obtain the use of the ligature in surgical operations as a means of controlling hemorrhage.

The ligature was first used, it is recorded, by Lanfranchi, of Milan, who also recognized the difference between arterial and venous blood. To Paré belongs the credit of its general introduction upon an enduring basis, and through this means of controlling hemorrhage in operative procedures, he made "amputations on a large scale possible for the first time in history." So little appreciated, at that time, was the great value of this most important contribution to surgical procedure, that Paré was compelled to "justify the use of the ligature before the Faculty by reference to ancient authorities." A great benefactor to the army, he received its adoration and was the recipient of distinguished honors from Royalty.

Considering the immense advantage gained in operative surgery by the successful control of hemorrhage which the ligature afforded, it would seem proper to give to its general introduction the importance of marking a new era in the "unfolding" or "orderly succession of events" which have characterized surgical development.

As up to this time of the recognized power exerted by the ligature in the absolute control of hemorrhage, so since then have no means or agents been discovered to displace it, notwithstanding the repeated efforts, through observation and experiment, which have been made, so that to-day, the perfected ligature—that which has been deprived by skilful preparation of all of the objections urged against the original—gives to the surgeon well-assured confidence in its use in any operation which may be undertaken.

The study of surgical progress in the second period which we have chosen, through the *sixteenth*, *seventeenth*, *eighteenth*, and a portion of the *nineteenth* centuries, from the time of Paré and his work, to the introduction of ether as an anæsthetic agent and its use, by Warren, in surgical operation for the first time in history, shows that much time was consumed and labor expended in the correction of the errors of ancient surgery and the establishment of the art upon a scientific basis.

Increased knowledge and experience permitted the application of a refining and elaborating process to the surgical operations practised in the previous times. To the list, already marvellously lengthened, considering the opportunities of that period, new operations were added, notably the operation of trephining, which it is recorded was performed seventeen times upon Philip William, the Prince of Orange, for inveterate migraine. In military surgery the new methods of warfare, with the use of arms of precision, presented to the army surgeons new problems with which they had to deal in the treatment of the wounded soldier.

The study of human anatomy, so auspiciously begun in the school of Alexandria three hundred years before the Christian era, was assiduously cultivated and became the foundation of correct surgical knowledge upon which the practice was built. In

due time and order important factors in the development of the science, comparative anatomy, physiology, pathology, chemistry, and therapeutics were brought to make their contributions to the growing science, broadening the fields of investigation and determining its scope.

The schools of instruction grew in value by expansion of courses of teaching, by elevation of the standard, and by the enrolment in their corps of instructors of men of learning and of distinguished attainments in surgical practice. Edinburgh became the birthplace of clinical teaching, and through the graduates of the University gave this method of surgical instruction to the institutions of this country, beginning with the Medical College at Philadelphia, the first of its kind in America, founded by Dr. John Morgan in 1765, in which Dr. William Shippen became the first professor of anatomy and surgery. The successor of this college now exists as the Department of Medicine of the University of Pennsylvania, with a long roll of eminent teachers of medicine and surgery. Notable as teachers of the latter branch are Gibson, Smith, Agnew, and Ashhurst. In Berlin and Vienna the schools were devoted largely, if not altogether in the beginning, to the teaching of military surgery and to the instruction of army surgeons. As evidence of the position of the surgeon in the Prussian Army, it is recorded that it was the duty of the regimental surgeon to shave the officers of the regiment, from which, it may be inferred, that he did not have the rank of an officer—wås, in fact, an enlisted soldier.

In the University of Göttingen surgery was taught by Albert von Haller, the distinguished professor of "therapeutical medicine," and he was qualified to teach this branch as "his mind was imbued with every department of literature and science."

Private schools of instruction came into existence in several places, notably in London and Edinburgh, that most distinguished being the school of William Hunter in Great Windmill Street, London, "inasmuch," as it has been aptly said, "it was the first perch of his more famous brother, John Hunter," not the least of whose monumental services to surgery was, as has been most happily

expressed by one of his eulogists, "that more than any other man he helped to make us gentlemen." In Edinburgh, Alexander Monro, "primus," occupied the position of Professor of Anatomy to the Company of Surgeons in 1719 and afterward in the University. As the first systematic teacher of surgery he is regarded as the "founder of the famous medical school of that city."

Any record of the schools of instruction would be incomplete without reference to those which were indeed pioneers, the schools of Italy, at Salerno, Naples, Padua, and Bologna, institutions in which culture in the highest degree was attainable, the training schools which gave to the world men of great eminence in all departments of learning, among these William Harvey, the discoverer of the circulation of the blood, who studied anatomy at Padua, under the illustrious Fabricius, the home of a distinguished line of teachers of anatomy whose labors so greatly influenced surgical development and growth.

The dominating influence exerted upon the unfolding of surgery in this period by individual effort was most marked, and gave character in the person of the author, the teacher, the original investigator, and in the practitioner. Through the labors of these, gradually, but surely, were the great principles of surgery evolved, which gave it permanence as a science and upon which as a sure foundation rested the expanding and successful cultivation of the art. To those names already mentioned should be added Richard Wiseman, designated the father of English surgery; Abernethy, Astley Cooper, Cheselden, Hey, Petit, Desault, Dupuytren, Larrey, Chopart, Cloquet, Amussat, Civiale, Scarpa, Schmucker, Richter, Siebold, and Callisen.

In the latter part of the eighteenth century there was born in a small country town in Kentucky, Ephraim McDowell. He it was who, in after years, through the operation of ovariotomy, opened the door of the abdominal cavity and established, as justifiable, operations upon the organs contained therein; robbed the peritoneum, the *noli me tangere* of former times, of its terrors, and bequeathed through his successors thousands of years of health and life to suffering woman. The great gift was not bestowed without hard-

ships and trials to his successors, who had to combat the antagonism of ignorance and prejudice, and to suffer, at the hands of members of their own profession, injustice and contumely.

Of what one suffered the writer of this knows, since, as his assistant and co-laborer for several years, he was a witness of the great wrong done him. Denounced as a murderer and one who should receive the attention of the District Attorney by a distinguished professor—teacher in a prominent medical college—in his lectures, deprived of recognition and place in the societies of his profession, he pursued his work with unswerving fidelity and in the firm conviction of right. Without the knowledge of to-day and without the help of modern "technique," he grappled successfully with cases surcharged with complicated conditions and of greater gravity than it seems come to the surgeon's hand to-day. With undaunted courage he met the dangers of hemorrhage, apparently beyond control, and of universal adhesions, and seldom closed the abdomen upon an incompleted operation. After years of professional work of this most arduous character—of unceasing devotion to the effort to place the operation of ovariotomy upon the foundation he believed it should occupy—as a justifiable and life-saving surgical procedure—his last days were made happy in the reception of professional honors and the assurance of high esteem and regard from those who had most strenuously opposed him. Such was the work of Washington L. Atlee, and in grateful memory of his worth and noble endeavors the writer would fain pay this humble tribute of respect.

Entering upon the third period we have set in the consideration of our subject, we find the list grows apace of those who, through their work in various directions, impressed, in marked degree and permanently, the unfolding of surgery. Upon it are inscribed the names of those in Great Britain, on the Continent of Europe, and in this country who promoted surgical science and gave to it dignity and rank. Among those not already named are Liston, Brodie, Wardrop, John and Charles Bell, Potts, Ferguson, Syme, Colles, Lawrence, Paget, Erichsen, Spencer Wells, in Great Britain; Lisfranc, Roux, Velpeau, Nélaton, Malgaigne, Chas-

saignac, in France; Schuh, Chelius, the two Langenbecks, Diffenbach, Czermak, Stromeyer, von Graefe, in Germany; J. Mason Warren, Bigelow, Mott, Wood, Mütter, S. D. Gross, S. W. Gross, the elder Pancoast, Nathan Smith, Agnew, Mussey, Dudley, Eve, Bobbs, the first to perform cholecystotomy; Pope, McDowell, Hodgen, Beaumont, and Stone.

Great as was the advance made in surgery up to the introduction of anæsthetic agents and their use in surgical procedures, it is impossible to overestimate the importance of this event to the science of surgery. The employment of agents to produce a state of insensibility, more or less complete, was not new, as it had been shown by abundant evidence that it was a practice of great antiquity, preparations of mandrake and hemp having been used for the purpose, as is recorded in the writings of Homer, Herodotus, and Pliny. As early as the third century a preparation of hemp was used among the Chinese as an anæsthetic during the performance of surgical operations. But it remained for Dr. John Collins Warren, surgeon to the Massachusetts General Hospital, Boston, in 1846, to demonstrate in the performance of a surgical operation the value of sulphuric ether as an agent which would produce a state of general anæsthesia in surgical procedures, placing the patient in a state of profound insensibility to pain, with complete removal of muscular resistance—conditions most favorable to the careful and unembarrassed performance of a surgical operation.

More than this, as it has been well said, it was a priceless boon to mankind, in that it removed the great dread of suffering under operations; in that it permitted the performance of operations hitherto impossible, owing to their delicate character and magnitude, and in that it contributed to lessen mortality by the prevention of shock and other untoward conditions.

Under the favoring conditions established by the introduction of anæsthetic agents the field of surgical endeavor was greatly expanded. Not only was operative surgery, through their beneficent influences, greatly promoted, but scientific research received an impetus which carried it into fields of inquiry hitherto unex-

plored, broadening the foundation upon which the great principles rested, and leading, step by step, to the ingrafting, in fuller degree, of collateral branches of science—the outcome of the labors of the original investigator in the laboratory.

As one of the results of these conditions the transcendental contribution of Lister stands pre-eminent and marks the greatest achievement in the history of surgery. Other contributions, valuable as they have been, lose prominence when compared with it and its far-reaching influence. Of little avail was the confidence the ligature afforded in the control of hemorrhage; the tranquil sleep which anæsthetic agents gave; the promise of restoration in the care exercised in the after-treatment, if dangers, unseen and beyond the knowledge of the surgeon, lurked within the recesses of the wound.

To know these and to overcome their evil effects was the great object of Lister's work, which, after years of thoughtful inquiry, painstaking and laborious research and experimentation, was gained, crowned with triumphal success. To him suffering from a wound, whether the result of injury or that made by the surgeon's knife, was given immunity from harmful agencies, with hopeful assurance of restoration to health.

Lister, in common with other surgeons, had observed the important difference which existed in the course of repair between the subcutaneous and open wound, and had endeavored, by the use of various forms of dressing, to prevent the conditions which developed and which were so hostile to the welfare of the patient. The object sought to be accomplished by these dressings was to exclude the air, which in some unknown way was thought to be responsible, from the wounded surfaces. Effective as they were in this respect, they intensified the hurtful conditions by confining the wound secretions, products of unhealthful action, and made easy the ingress into the system of their evil influences, producing pyæmia and septicæmia.

Reaction in opinion followed observation of the results produced by these forms of dressings, and led to their abandonment by some surgeons and to the treatment of wounds without dress-

ings of any kind, or to the application of those, most simple in character, which permitted the free escape of wound fluids. The reparative process was thus promoted, and in many cases was satisfactory, but not as uniformly as was desired, and the search continued for a solution of the problem, the discovery of the causes concerned in the production of the abnormal conditions attending the healing process.

As experience had shown that these conditions prevailed to greater extent when patients were crowded together, better methods of hospital construction were adopted, by which segregation of patients was secured and ample air-space with more perfect systems of ventilation.

The study of the experimental researches of Pasteur into the causes of putrefaction led Lister to the conclusion that "the evil conditions observed in open wounds were due to the admission into them of organisms which exist in the air, in water, on instruments, on sponges, and on the hands of the surgeon, which, finding a suitable nidus for their development and growth in the discharges and surrounding tissues, germinate in them and alter their chemical constitution, forming various poisonous compounds, which, if absorbed into the blood, give rise to pyæmia and septicæmia."

It was, therefore, most desirable and necessary to prevent the entrance of these organisms, in active state, into the wound, to adopt some measures by which they could be destroyed before or after admittance into the wound, to secure the removal of discharges, and to prevent their accumulation in the wound-cavity, in this way maintaining the tissues in a healthy condition, which state is, in itself, destructive to germ life.

To obtain a substance which was destructive to the organisms and harmless to the tissues was an undertaking attended with some difficulties. From the original crude, carbolized putty dressing to the perfected dressing of to-day; from the unfitted and uncleanly operating-room, surcharged with carbolic acid vapors, to the completely constructed, germ-proof operating arena of to-day, equipped with all the modern appliances needed

in surgical operation, in which, above all, the goddess of cleanliness reigns supreme, was a long stride, and has been accomplished only through study and investigation, supplemented by accurate observation and well-digested experience.

The profound influence exerted by the achievement of Lister the profession of medicine has not alone felt, but every department of life has been brought to a knowledge of its value and importance in the study and practice of sanitary science; in the adoption of methods which contribute to the preservation of health and the prevention of disease, in the nation, in the city, and in the home. The gospel of cleanliness has its ministers and teachers in the household, its earnest missionaries in the slums of the city, in the mills and factories, and as well on the farm.

He who can thus influence the life of his fellowmen is indeed a benefactor, and it is to the great glory of surgery that through the efforts of one of its disciples came this beneficent gift to man.

As the direct result of these most important contributions to surgical knowledge, the introduction and use of anæsthetic agents in operations and of antiseptic methods of wound treatment, operative surgery has made great advances in every direction, most pronounced in operations upon the abdominal, cranial, and thoracic cavities.

As the door of the abdominal cavity had been opened through the courageous efforts of McDowell, into this entered the surgeon, and, under the protecting ægis of anæsthesia and asepsis, attacked organ after organ with successful result. Operations for the relief of morbid conditions, charged with the gravest complications and hidden dangers, have been undertaken and have been executed with a daring which has challenged admiration and disarmed criticism.

Operations of greater or less magnitude have been performed in ancient times upon the thoracic cavity, including puncture and rib resection. These have grown in frequency and importance, while incision of the pericardial sac and suture of the heart walls are among more recent triumphs of surgical skill and daring. Exposure and massage of the heart through incision of the

diaphragm, for the relief of narcosis produced by anæsthetic agents, has been recently performed, and may well be designated as the climax of boldness in surgical procedure.

Magnificent as have been the achievements in operations upon the abdominal cavity, those upon the cranial cavity can claim almost equal rank. Here not only anatomical and physiological considerations have to be dealt with, but also psychical. "The interrelation of cranial tissues and organs, their capital importance in the physical economy, and the position of some of them, as the substrata of mental activities render any surgical interference a matter of great delicacy and grave anxiety." In this field the labors of the physiologists and clinical observers have yielded the most important results, the practical outcome of which has been the mapping out of the surface of the brain into a series of topographical areas and the establishment of the theory of the localization of function—motor, sensory, and psychical. Supplementing these investigations came anatomical and surgical inquiry, the object of which was to define the relation which existed between the cerebral convolutions and external cranial landmarks. This addition completed the circle of information, and permitted the surgeon to apply to operations upon the cranial cavity the ordinary rules governing surgical operations.

In any record of the progress of surgery mention must be made of the great advances which have taken place in military surgery. The entrance of men of scientific attainments into the medical corps of the army and navy has been signalized by corresponding development and growth of surgical art and science, as witnessed in the improved methods of hospital construction, the expansion of the work of the ambulance service, the equipment and use of the hospital train and of the hospital ship, the improved sanitation of the war-ship and of the camp—the marvellous results obtained by experimental research and practical endeavor in preventive medicine.

The organization of associations having for their object the cultivation of surgical science has exerted a beneficial influence in securing the diffusion of surgical knowledge, the creation and

the defining of surgical opinion, and the promotion of social intercourse. Such was the intent of the eminent founder of this Association, who, as teacher, as the eloquent expounder of the great principles of surgery, as author, and practitioner, was so active and earnest in his efforts to obtain the higher development of surgery and to elevate the standard of the profession.

Thus, in the unfolding of surgery, from the crude to the perfected art, without scientific basis, to the highest development of science, without relation to collateral branches of knowledge, gradually absorbing those elements essential to normal growth, has been evolved the surgery and, with it, the surgeon of to-day. From the bleeder, the nail-trimmer, and ear-borer, through the regimental barber, to the accomplished scholar, the author of elaborate treatises, the trained teacher of principles and of practice in schools of instruction, the astute diagnostician, the learned pathologist, the patient investigator, the dexterous operator, the skilled practitioner, recipient of high honors from the institutions of learning of the world, and crowned, above all, as the refined and cultured gentleman.

GASTROSTOMY IN ŒSOPHAGEAL STRICTURE.

By JAMES H. DUNN, M.D.,
MINNEAPOLIS, MINN.

In frequency and in difficulty of cure, cicatricial stricture by far overshadows all other benign affections of the œsophagus. Despite the great ingenuity and perfection of modern methods and apparatus for dealing with disease of this organ, a strangely large proportion of these strictures still come to the surgeon soon or late in a practically impassable condition; that is, in such condition that no guide can be made to reach the stomach, or more frequently, though with much patience and skill, fine instruments may be passed; dilatation, even with the many and constantly increasing number of clever devices, is tedious, difficult, inefficient, and often dangerous.

Doubtless there are several reasons for this fact. In some instances the extent and severity of the primary lesion may be such that the best efforts of both the patient and his attendants are unavailing in preventing progressive contraction. More frequently the ignorance or carelessness of the patients or their sponsors is a decided factor, while occasionally faulty diagnosis or strikingly inefficient treatment must be suspected of a large responsibility for allowing these strictures to reach a state requiring opening of the stomach. Yet, after all proper allowances are made for such extrinsic factors, these progressive relapses are, it is believed, chiefly and most fatally due to two defects in the methods of treatment commonly in vogue:

1. To a prolonged, often months or years, irritation and infection of these coarctations with food and instruments.

2. To a failure to promptly restore the calibre of the tube to something approximating the normal. Such a course is most favorable to the continued increase of scar tissue and to the relapse and aggravation of the stricture.

The importance of a prompt and approximately complete restoration of the urethral calibre in securing something like permanence of results in urethral strictures has been generally appreciated since the important work of Otis; but the average practice as well as the usual instruments, even the most recently designed for the treatment of œsophageal stricture, show that the ability to swallow with reasonable satisfaction is too often taken as the standard of dilatation rather than an approximate restoration of the normal calibre, precisely as, prior to the teaching of Otis, satisfactory urination was the end of active treatment in urethral stricture until the inevitable relapse forced the patient to seek relief from a worse condition than his first.

With the methods now at our disposal, especially with Dunham's apparatus, most strictures of large calibre and many readily dilatable ones, even of the smallest calibre, through which a filiform bougie can with patience and skill be worked, may and should be treated from above. Presumably no one would advise opening of the stomach in treating such cases. It is decidedly not the writer's intention to countenance such a procedure. He cannot, however, sympathize with the views of many—*e. g.*, Bentz, who claims that "retrograde dilatation ought rarely to be necessary, even in the most serious cases, and that temporary gastrostomy is a serious, troublesome, and dangerous procedure." Quite on the contrary, there are distinct advantages in extending rather than limiting the field of temporary gastrostomy and the through-and-through treatment of all very difficult œsophageal strictures, applying it not only to the really impassable ones but to many others. These antagonists of through-and-through treatment often report cases as a great victory in which by diligent work through three or four months a moderate opening has been secured. Perhaps less danger, more comfort, a better and surely a more rapid result could have been secured by the method which it is the purpose

of this paper to advocate, first, and particularly in impassable strictures, and second, in cases especially difficult, tedious, or dangerous to manage from above.

Opening of the stomach and retrograde or through-and-through treatment of certain œsophageal strictures has been generally recognized since Loretta's operation in 1883. This operation was based upon the undeniable fact that, owing to dilatations, distortions, and changes above the stricture, retrograde sounding is often readily accomplished when passage from above is impossible. Indeed, the basic principles in the treatment of this condition are:

1. To safely get a reliable guide through the canal.
2. To divide the scar tissue sufficiently.
3. Efficient gradual dilatation.
4. Relative asepsis and rest of the wounded surface by preventing the stagnation of food, and for a time even the irritation of its passage.

Discoveries and improvements in operative technique, thanks especially to Abbe, Stamm, and Dunham, have been from time to time made, which have finally completely changed the situation, leaving us in a position to approach one of these cases with a very definite, certain, and safe technique, with a minimum of discomfort to the patient, and it is believed with a more permanent result.

It is perhaps needless to say that no essential originality is here claimed, but the fact that the writer did not fully appreciate the full advantage of many points in the methods advocated until he had in a measure rediscovered them in their application, led him to believe the matter worthy of reiteration and discussion.

During the first decade after Loretta's operation opinion seemed to be divided as to whether it should be done in one or in two stages. Ten years ago Kendall Franks predicted as follows: "I believe Loretta's method will come more and more into use, for the reason that with proper precautions the risk of opening the stomach at once can be reduced to practically *nil*, while if we form a fistula we must forego certain other very decided advan-

tages to the patient." This prediction has failed absolutely, because a practically sure method of getting a guide through (Dunham's string washing) and an improved gastrostomy has robbed the procedure of Loretta of all possible advantages, while all its disadvantages remain with it. On the other hand, the many disadvantages of the one-stage operation are nearly eliminated in the present method:

1. The operation is far less severe and much safer.

2. Starved patients may be recuperated before treating the stricture.

3. The treatment of the stricture may be much more thorough, scientific, and complete before the stomach is closed.

4. A greater degree of cleanliness and rest of the œsophagus during the healing of the internal œsophagotomy is secured.

However, the practice, particularly in England and America, has always favored a two-stage operation. And, although the results have been fairly satisfactory and the mortality small, a faulty technique has rendered the treatment far from ideal. Often the gastric fistula has been very troublesome and required a second operation for its closure. This operation having originally been undertaken for the distinct purpose of retrograde sounding, the inclination is to make the fistula unnecessarily large. The importance of the Stamm-Kader form of gastrostomy is becoming generally appreciated in these cases, and those with much practical experience with it appreciate that if the tube used be very large, leakage is apt to occur; but it is only when one comes to fully appreciate by practical experience that any œsophageal stricture may be *commanded perfectly and with precision by means now at hand, through very small gastric fistulæ*, even those the size of a No. 20 French catheter, that all the advantages of this method appear.

About two years ago the writer's attention was attracted by the methods and instruments of Dr. Theodore Dunham, through the kindness of Dr. Mixter, and since then he has evolved a technique which in his last three cases has proved so satisfactory as to be a revelation to himself of the possibilities of a combination of the

principles and methods chiefly devised by American surgeons in the treatment of severe and difficult cicatricial strictures of the œsophagus.

The first step is the application of the Stamm-Kader gastrostomy. The operation is too well known to require any description, but the size of the tube is of the greatest importance, especially in some cases—*e. g.*, in an emaciated infant with a very small and thin stomach, perhaps with the severe cough and irascible disposition of such long-starved children, crying and fighting incessantly for food, anything larger than a No. 20 feeding tube is likely to give great trouble from leakage. In no case, even in adults, is a tube larger than a No. 30 French scale necessary or desirable. This procedure requires but a few minutes, is practically without danger, even in very weak subjects. If a brief general anæsthetic is feared, it may be easily done under local anæsthesia. The starved patient may be at once fed through the tube and recuperated for a week before further disturbance by treatment. The dangers and discomforts of this operation are less than those accompanying a very difficult sounding.

The second step is now undertaken: After a week's absolute rest of the œsophagus and feeding through the tube, it is a matter of common observation that the stricture is usually decidedly more permeable, and it is exceedingly rare that water cannot be swallowed with considerably more rapidity than at the time of opening the stomach. By Dunham's string-washing method a strong black thread is washed into the stomach and readily fished out with a blunt hook. If in rare cases, especially in children with a stricture so tight that water cannot pass in a continuous stream, however fine, this procedure does not at once succeed, patience and repeated trials will not fail. The thread having passed, a long loop of fish-line is drawn through to the mouth, giving two guides through the œsophagus. To one of these a small wire and spindle bougie (Dunham's) are attached and drawn through from below. Others may follow until the size of the gastrostomy opening is equalled, when retrograde passage of the bougies is changed to drawing them through the mouth into the

stomach, and then back, without stretching or disturbing the small gastric fistula. As soon as the bougies begin to wedge tightly in the stricture the other fish-line by Abbe's admirable method releases it by a few chafings. This is continued until the stricture is opened up as widely as is deemed safe at one sitting. In case a good free calibre is at once established the gastrostomy tube may be immediately removed, and the fistula very promptly heals. This course was pursued in one case. There was not a drop of leakage at any time, and the fistula was soundly healed in two weeks. Should it not be deemed safe to raise the calibre so rapidly, or desirable to longer keep the œsophageal wounds from contact with ingesta, the tube may be retained another week or two, and at intervals of three or four days renewed dilatation and string sawing resumed until a calibre admitting of easy handling from above is reached. Dunham's apparatus contains a "string tunnel œsophagotome" for sawing strictures from above, but it is certainly much more facile for both patient and surgeon, the stomach once having been opened, to continue the through-and-through method until a good calibre has been attained and the further use of the string-saw rendered unnecessary. While Dunham's wire and spindle bougies are very excellent instruments, the writer has found similar spindles tunnelled to slip over "stout string" or fish-line upon which they are fixed by knots in the string, a simpler, handier, and equally efficient apparatus. Nor has the writer found it necessary to employ the guards to protect the epiglottis and stomach from the chafing of the string, which only cuts where it is tightly wedged in the stricture by the spindle. This reduces the special apparatus to a set of spindles, a fish-line, a strong black thread, and a glass funnel and catheter for infants, or a glass drinking tube for older children and adults. With this very simple armament, all of which with the exception of a set of dilating spindles may be extemporized in any hospital on a few moments' notice, one may feel complete master of any œsophageal stricture, however difficult, and may proceed with a precision, safety, and success unequalled by any other method so far devised. It cannot be denied that stricture may be treated with more or less success

by various methods, but that one which combines the greatest simplicity, safety, and comfort to the patient, which admits of the most rapid, and cleanly, and undisturbed healing, and which may be reduced to the most definite and precise technique, must be admitted the superior.

Abbe's string-saw, in connection with Dunham's wire and spindle bougies, would appear to be the safest, simplest, and most efficient means for rapid enlargement of these strictures, and preferable to divulsion or continuous dilatation by drawing in elastic rubber tubes. Though considerable success follows the use of such methods, precisely as the divulsion and continuous dilatation of urethral strictures has not been without success, yet more precise and surgical methods are to be preferred. In most cases by this method the œsophageal calibre is rapidly brought up to a size admitting of comfortable swallowing—*e. g.*, about the size which is commonly regarded as sufficient, and often reached only after months of persistent dilating from above. Such a size having been comparatively rapidly attained, then progressive dilatation should be continued regularly until a size much larger than the calibre of the sounds and bougies usually found in the instrument shops is attained. After this has been accomplished, prophylactic sounding at longer and longer intervals should be insisted upon.

By this plan it has not been found necessary to give an anæsthetic more than once in each case. The gastric fistulæ have not leaked and have promptly closed spontaneously. A calibre admitting of the free swallowing of solids has been reached in from one to three weeks, and an approximately normal calibre reached in from two to four months, after which the tendency to relapse has not been marked. One case, having passed a bougie only once in three months for the past year, shows no appreciable recontraction. Of course, as is well known, cases of enormously extensive or total stricture of the œsophagus are refractory under any method of treatment.

Case I.—Miss Rose P., aged nineteen years. In April and May, 1902, had a severe typhoid fever; severe hemorrhages from the

bowels in the third week; in the fifth week otitis media of the right ear. At the end of the sixth week left hospital for her home in the country. Before leaving she had called her physician's attention to some difficulty in swallowing, but he had assured her that it was due to a paralysis of the muscles of the throat, and would recover in time. After going home she experienced progressively increasing difficulty in swallowing, but consulted no one, as she and her parents supposed it a sequel of typhoid which would pass off in time, besides they were rather phlegmatic people, living remote from a physician. She had furthermore been living on milk and fluid diet, hence the seriousness of the dysphagia was not fully appreciated, though she was extremely emaciated. By August 1st she was practically unable to swallow anything; even water was ingested with great difficulty and in very small amounts. This forced her to seek medical advice at San Raphael's Hospital, where she was fed per rectum, and attempts were made during the next week to pass bougies of all kinds, but without avail. The stricture was located 30 cm. from the teeth.

August 10th. Stamm-Kader gastrostomy, No. 30 French tube. Patient was fed by stomach tube for two weeks while waiting for a set of Dunham's instruments ordered from New York.

The string was readily washed through; the No. 10 wire and spindle bougie could not be drawn through the stricture with considerable force, showing the stricture to be remarkably tight and unyielding, but by means of the string-saw and bougies it was at one sitting brought up to No. 36, and a few days later to a calibre admitting the largest bougie in the set.

The stomach fistula was then allowed to close. A special set of dilators was ordered made. For eight weeks bougies gradually increasing in size were passed every second day until one 65 mm. in circumference was easily passed. She then had this bougie passed at one, two, and three weeks' intervals until April, 1903. Since then bougies passed once in three months show no evidence of any tendency to recontraction.

Case II.—S. B., female, aged nine years. Four years ago accidentally drank concentrated lye. Five months later began

the passage of bougies two or three times a week. This was continued very regularly for a year; as near as could be learned nothing larger than a No. 22 had been passed. For the past eight months a small bougie, No. 20, had been passed very regularly two or three times a week, but it had evidently never, or not for a long time, reached the stomach. For the past nine days very little if anything had been swallowed; even water, unless taken very slowly, was regurgitated. She was very emaciated and too weak to sit up long at a time.

Examination showed one stricture about 20 cm. from the teeth, of about 20 calibre, through which a bougie had been passed for four years. Near the cardiac end was an obstruction through which it was impossible after many attempts to pass a filiform bougie.

September 15, 1903, a temporary Stamm-Kader gastrostomy with a No. 30 tube was made. The patient, fed by the tube for a week, was much relieved. September 22d a guide-thread was readily washed through; the stricture was tight enough to grasp a loop of fish twine quite tightly. With Dunham's wire and spindle bougies and Abbe's string-saw the stricture was at once raised to No. 24, from below upward, then from above downward, up to 38. After forty-eight hours the tube was removed from the stomach, and feeding by the mouth allowed. Deglutition of solids and liquids appeared to be quite normal. There was never the slightest leak before or after the tube was removed, and the fistula closed promptly. From September 25th to November 10th gradual dilatation was practised, at first every second, and later every third day. At this time she passed a No. 46 bougie without difficulty, and she had become very fleshy, and returned to her home in the country. Perhaps the dilatation should have been carried somewhat farther, as the lower coarctation, about 2 cm. in length and very unyielding, could still be very distinctly felt by a large bougie, but in a rather small child of nine years it was thought that a calibre of 45 mm. might be tentatively tried for a while, and she was directed to pass the bougie twice a week and return for examination in three months.

Case III.—Eva W., aged two years. Nine months ago, when fifteen months of age, the child drank concentrated lye. She was very sick for three weeks, and finally vomited up a complete ring of dead mucous membrane, half an inch wide, which the attending physician examined and drew on to his finger. About eight weeks after the accident difficulty in swallowing liquids became manifest, and she had lived on liquids ever since for the past four months; these were ingested with increasing difficulty, the child fighting furiously and nearly constantly for anything to eat or drink, filling its dilated gullet with liquids only to regurgitate apparently all or nearly all in a few minutes and cry and fight for more. It had an almost incessant cough, and was literally wasted to skin and bones, its thighs being the size of a man's finger. The parents had been urged to have the child operated upon three months before, but had gone from one physician to another, with the hope of getting a dilatation from above, and though many attempts had been made by different physicians to pass bougies, none succeeded. At last, when convinced that the child was nearing its end from starvation, they consented to opening the stomach.

November 11, 1903, at St. Mary's Hospital, the temporary gastrostomy was made. The stomach was astonishingly small and thin, so that we hesitated to turn too much of it in when making the Stamm-Kader operation, and a large tube, 24 French, was used. The long-starved child coughed and cried and fought for food with its mother, who could not be induced to leave it, putting the severest possible test on the fistula, and there was after a few days a slight leakage, which proved most annoying. On the eighth day a string-guide was washed through without difficulty, and by the method described in the previous cases the stricture readily raised to a calibre of 32 mm. All attempts to control the leakage by retention catheters simply made matters worse; finally, all efforts to that effect were abandoned and the tube was removed, then the fistula soon closed and the child rapidly gained in flesh and strength, ceased to cough entirely, and left the hospital for its home at Howard Lake, December 23d, forty

days after the gastrostomy, with instructions to pass the No. 32 twice a week and gradually increase it up to 36, which might be regarded as sufficient for the present, at least in a child of two years. The temporary but very considerable annoyance of the leakage might quite certainly have been avoided by using a still smaller tube. A No. 15 or No. 18 catheter would have served all the purposes of the dilatation by this method, and it is equally certain that in such a case the smallness of the fistula is, next to the enfolding of the stomach, the greatest guarantee against leakage and delay in spontaneous closure.

DISCUSSION.

Dr. Robert Abbe, of New York City.

In regard to the string method which the essayist has amplified, with Dunham's improvement, it does not seem to me that the method ought to be thus complicated. When first devised it consisted of a string and conical bougies, which were introduced through the gastrostomy wound. The surgeon can make as large an opening as he desires, and it can be subsequently closed. If you make three successive purse-strings, with a tube left in the stomach, there will be a speedy closure of the opening, nor will it leak around the tube.

There is one thing that has been misrepresented in this operation—that is, that it is difficult. The essential principle is this: Conical bougies can be passed through a stricture from below, as Billroth showed, because the entrance is conical looking upward, while above it presents a surface more like the bottom of a cup. Successive dilating bougies are passed until the resistance is great. Then the string, previously placed in the œsophagus, is see-sawed back and forth while the bougie is pushed onward. When the stricture is stretched the string cuts, the parts being under tension. The first patient upon whom I operated by this method (twelve years ago) is absolutely well to-day; has never had any trouble; swallows the largest amount of food, and has had no recurrence during that period.

Dr. Frank E. Bunts, of Cleveland.

I was very much interested in the paper of Dr. Dunn, and I would like to ask a question, as I have not been able to satisfy myself as to what the indications are for performing gastrostomy and retrograde dilatation. If one of the indications be a stricture, so small that a filiform bougie cannot be passed through it, then the question is hardly debatable. If, however, we take it for granted that we can pass a filiform bougie, then the stricture may be dilated to a sufficient size to avoid the necessity for doing a gastrostomy. It has been my fortune to have had eight successful cases of cicatricial stenosis of the œsophagus, all following the drinking of concentrated lye. In three of these cases even water could not be swallowed. In five other cases solids could not be swallowed. In none of these cases did I find it necessary to do a gastrostomy. All of them, with the exception of one child, aged eight months, are living, and this child is not living because the parents were unable to bring it to the dispensary for proper attention.

It has been my experience that it is difficult to pass a bougie of any

kind, and the bougies which we have found in the instrument shops are entirely too large, most of them; so I find it necessary to have filiform bougies made. I found I could not pass the filiform bougie on the first or second day, but by allowing a little interval to pass, feeding the patients by rectum, I have been able to get through a filiform bougie, and have been successful in dilating these strictures the same as one would dilate strictures of the urethra.

If the point brought out by Dr. Dunn, that a symptomatic cure is not a cure, is correct, then I cannot claim anything for gradual dilatation of œsophageal strictures. Some of my patients, after dilating their œsophageal strictures, have grown stout and fat, and enjoy life. Some of them either pass the bougies themselves or I pass one for them at intervals of three or four months. The recontraction of the stricture is not rapid in any case, and only moderate attention keeps them in good condition. I have found it advantageous to have a special form of bougie made, which is modelled after the Trousseau instrument, yet somewhat different, having two conical bulbs on the staff, separated about an inch and a half, varying in size of about one degree, French scale. If I pass one bulb I am sure I can pass the second, which is on the same staff. Increasing the successive dilatation I have been able, in the eight cases which I have had, to cure symptomatically all of them, except the child who died from lack of attention, without gastrostomy.

Dr. Dunn. I do not think Dr. Abbe understood me. I understood him to say that, large or small, if the gastrostomy opening is made properly there will be no leakage. I believe there are two reasons for the prevention of leakage. If the stomach is turned in for a considerable distance, there is less tendency to leakage, but in my experience in certain cases if the opening is of large size there will be leakage. Take, for example, the case of the child, and I think the lye was drunk when the child was five months old, and the stomach was not larger than that (indicating). It was very thin. If you put in a tube of large size, and insert three puckering strings, you would see a good share of the stomach in a case like that, and with the child crying, coughing, and straining all the time, it must be a good gastrostomy opening that will not leak.

As to the indications for this operation, I said that one of the first indications was those cases in which no filiform bougie could be introduced into the stomach. Second, all of those which were difficult strictures, which could not be readily treated by dilatation, and I am quite sure we have a great many such, especially if we have a stricture low down in the œsophagus near the stomach. In any case in which there is great danger or difficulty in dilating a stricture the open method

is much preferable, and certainly the history of the past shows that some patients die from attempts at dilatation of these strictures. I cannot draw the indications perhaps any clearer than I have, and I would suggest that the speaker's cases (referring to Dr. Bunts) may have been more recent. In my cases many attempts at dilatation of the strictures were made, and they were more or less inefficient. When a stricture becomes old and is not readily dilatable I doubt if I could get as good results with the class of cases that I have had to deal with by dilatation from above.

A CONTRIBUTION TO THE SURGERY OF NERVES. THE BRIDGING OF NERVE DEFECTS.

By CHARLES A. POWERS, M.D.,
DENVER, COL.

It is difficult to make a satisfactory review of this subject. The operation itself deals with those cases in which approximation of the divided nerve segments—simple nerve suture—is impossible; but we know that ordinary neurorrhaphy, primary or secondary, is not invariably successful, for it happens only too often that under favorable conditions of approximation the functional result is far from perfect. In the present state of our knowledge it is not easy to give the percentage of failure in suture with good approximation, so that in attempts at bridging incoercible separation of the divided ends of a nerve we are uncertain as to how much of the success or failure depends upon factors which are not under the control of the operation itself. In other words, given a case in which some form of attempt at bridging has failed, it is impossible to say that a good functional result would have been secured had perfect approximation been obtained.

Other difficulties are referable to the manner in which the subject of nerve suture is treated in medical literature. The *Index Medicus* has no classification of it, and the writer[1] has endeavored to consult all of the sections which might bear indirectly thereon. Most of the studies on nerve surgery are hidden away in such sections as operative surgery, surgery of the extremities, surgery of the head and face, etc. Such a condition has a twofold signifi-

[1] The author acknowledges his indebtedness to Dr. Edward Preble, of New York, for valuable aid.

cance, for, while it argues some defect in the method of indexing, it implies at the same time that the subject itself is not one of great importance or interest.

It might be thought that the enormous amount of material in the domain of surgery of the nervous system collected and published by Chipault should contain everything of interest upon the subject of nerve suture. But the *Etat actuel de la chirurgie nerveuse* contains no analytical index, and of the large number of references cited in the work which bear upon this subject very many—especially the inaugural dissertations of foreign universities—are inaccessible to the American reader.

Further, it should be emphasized that much of the material comprised in the literature of the subject consists of operations upon animals. Quite a number of authors whose names are mentioned in connection with the work—Vanlair, Assaky, and others—never reported cases in human surgery. Létiévant, who is much quoted for his pioneer work in this field, operated but twice on the human subject, and the result in each case was complete failure.

Finally, a large proportion of the operative cases are reported at a period before the establishment of a permanent result and at a time when early return of sensation may be explained by collateral nerve supply, and early return of motion may be considered due to vicarious movements of other muscles than those formerly paralyzed. (Peterson.)

The subjects of nerve repair and regeneration, of simple neurorrhaphy—primary and secondary—and of the more simple and obvious means of approximation of the divided ends of nerves, such as stretching and posture, are fully discussed in a somewhat abundant literature, as are likewise such allied procedures as neurolysis, the implantation of a healthy nerve into the nerve of a paralyzed muscle, and the after-treatment of nerve suture, however performed, by electricity and massage.

On the other hand, the more unusual resources for restoring the continuity and functions of severed nerves have a relatively small literature, at least so far as attempts at considering the

entire field in a single paper are concerned. Individual case-reports abound, and in some of these attempts are made to consider the subject of bridging defects at some length, but actual monographic studies are but little in evidence.

In Chipault's *Chirurgie opératoire du systeme nerveux*, 1895, we find a systematic account of this subject, but without a complete list of cases. In the same year Huber made a meritorious attempt to collect all of the recorded cases in which nerve defects were bridged (*Journal of Morphology*). His combined material amounted to some 22 cases, over half of which were examples of the grafting of foreign substances.

In 1894 Spijarny published in an inaccessible Russian journal a list of nearly 200 cases of nerve suture of all kinds found in literature, and of these 30 concerned the bridging of defects. There were 11 operations of flap-splitting, 11 of foreign grafts, 1 of implantation, 1 of *suture à distance*, 4 of tubulization, and 1 of resection of bone. This series is of no special value, for some cases are said to be recorded twice, while the tubulizations are in part cases of simple suture with the superaddition of tubulization.

There are also several inaugural dissertations which treat of bridging defects, but the writer has been able to consult only Ehrmann's *Contribution a l'étude de la suture de nerfs à distance*, Paris, 1896. This author, while discussing all of the operations for bridging defects, confines his actual material to *suture à distance.*

There are a few monographic studies devoted to particular operations. Thus Peterson (*American Journal of the Medical Sciences*, 1899) has certainly done all that was possible with the subject of grafting proper, relating twenty histories in all, several of which appear for the first time. Dumstrey, "Ueber Nervenpropfung," *Deutsche Zeitsch. f. Chirurgie*, lxii. (1901–02), made a rather unsatisfactory attempt to collect the published cases of nerve implantation, a number being omitted. Ehrmann's thesis on *suture à distance* has already been mentioned; it contains all of the cases (3) of this operation to date (1896). The writer does

not learn that the subjects of flap-splitting and resection of bone have ever been submitted to a critical study.

The sections on nerve surgery in Chipault's monumental *Etat actuel de la chirurgie nerveuse*, 1901–03, contain much material of interest on bridging defects, although this occurs in scattered fashion.

As already intimated, it is doubtful if a complete series of cases of the bridging of nerve defects can be compiled. The plan pursued by Chipault in securing a surgeon from every country in the world to collect the material of his own land has made the list of inaccessible publications much larger than would otherwise be the case. Moreover, a study of the entire material of neuroma would probably lead to the discovery of cases of implantation, etc., which have escaped the compiler. Thus Maydl and Kukula, who covered the material of Bohemia for Chipault's work, speak of two cases of nervenplastik as having been done in that country, although details fail.

Excluding all doubtful cases the material found is as follows:

Grafting	22
Flap operations	11
Implantation[1]	10
Resection of bone	7
Suture à distance	5
Tubulization	1
Total	56

GRAFTING.

In this section the writer will use Peterson's admirable analysis, after first inserting two cases not included therein, one being his own. These are as follows:

Durante (*R. Accad. Med. di Roma*, April 24, 1892) in removing a tumor (osteosarcoma) of the head of the fibula was obliged to resect a portion of the external popliteal nerve. As it was found

[1] Only those cases are taken in which the operation was undertaken to correct a defect. Cases of implantation for the relief of facial and Duchenne paralysis are not included.

to be impossible to approximate the severed ends, he inserted a graft of 5 cm. of dog's sciatic, suturing it in place with catgut. After operation movements of toes and foot notably improved, particularly those of dorsal extension and abduction; sensation also improved. (Report made at the end of a month.) However, rapid recurrence of the malignant growth made it necessary to amputate the leg. Dissection showed that the graft had entirely disappeared. An accurately recorded result is not given. We simply gain the impression that the result was good at an early day after operation. This is a fair illustration of the difficulty which the writer has experienced in judging of the results in the cases found in literature. Generalities abound, but accurately recorded late results are scanty.

Author's Case. *Nerve transplantation; implantation of four inches of the great sciatic nerve of a dog in the external popliteal of a man; result at end of eight years.*—C. O., a young man of eighteen years, came under my care at the Denver City Hospital May 10, 1896, with a history of having been run over by a railway train twelve hours before. On examination he was found to have a crush of the right great toe, deep lacerated wounds of the right gluteal region, and a fairly extensive lacerated wound at the outer aspect of the right knee, with a compound comminuted fracture of the head and neck of the right fibula. There was complete anæsthesia and paralysis of the parts supplied by the external popliteal nerve. Dirt and coal-dust were ground into all of the wounds. Under ether the toe was amputated, the gluteal wounds cleaned and sutured, comminuted fragments of the fibula removed, and the lacerated wound at this point trimmed, cleaned, and partly sutured. The popliteal nerve was not found in its usual place below the head of the fibula. An attempt was made to locate its ends, but they were not easily found, and prolonged search was not made. It was thought wise to first gain healing of the wound and then make secondary suture of the nerve. The wound healed in part by primary union, in part by granulation. June 27th it was closed, and on that day nerve transplantation was done as follows:

Ether. Esmarch's bandage. Seven-inch incision at outer aspect of knee. Scar tissue removed. The lower end of the upper fragment of the external popliteal nerve was found without difficulty. It was bulbous. Considerable time was spent in searching for the lower fragment, the peroneus longus muscle being fully exposed. An incision was made in front of the fibula, and the anterior tibial nerve was found lying on the extensor longus digitorum. This nerve was traced upward and the external popliteal discovered, its bulbous end being about one-third of an inch above the division of the nerve into the anterior tibial and musculocutaneous. Both bulbous ends were pared; about three and a quarter inches of space intervened.

During this work my colleague, Dr. Freeman, had kindly exposed the great sciatic nerve of a thirty-five pound dog. A fragment four inches long was removed, passed between the peroneus longus and the fibula of the patient and implanted in the external popliteal. Three sutures of fine chromicized catgut were used at each end, one suture being passed through the nerve substance, the other two uniting the sheaths. The fragment was slack, and the ends lay in perfect approximation. The external wound was sewed without drainage, the knee placed at an angle of 135°, and a large aseptic dressing with plaster-of-Paris splint applied. Primary union. The knee was confined for a month.

Just before the operation the patient was examined by Dr. J. T. Eskridge, neurologist to the hospital, who reported anæsthesia of the skin area supplied by the external popliteal nerve together with complete paralysis of its muscles. According to notes made at the time, Dr. Eskridge examined him again on July 20th, saying that the anæsthetic area remained about the same as before operation. August 4th he says: "Temperature, pressure, pain sensations, and ability to recognize cold substances have returned over the entire anæsthetic area. Tactile and localization sensations and ability to recognize warm substances are a little impaired. All forms of sensation are delayed." Under date of August 11th he says, "All forms of sensation normal." On August 13th Dr.

Eskridge reported that the tibialis anticus and peroneus longus would not respond to the strongest faradic current.

At this time the patient left for his home in Michigan. I did not hear of him again until April of the following year, at which time Dr. Reuben Peterson kindly examined him and reported as follows under date of April 3, 1897:

"Patient can feel the touch of a pencil over the entire leg and foot, but sensation is somewhat diminished over an area three or four inches long by a couple of inches wide at the external part of the lower third of the leg and on the internal aspect of the instep down to the scar made by the removal of the great toe. There is considerable atrophy of the muscles of the leg in the upper third. Circumference of the right leg, eleven inches; left, twelve inches. Middle of calf, 12 inches on the left leg; eleven inches on the right leg. Upper third, right, seven and three-quarter inches; left, eight and a quarter inches. Abduction of foot impossible. No movement of toes except those controlled by extensor tendons. First and second toes somewhat contracted. Unable to hold foot up. Has good movement in walking except that he has to lift right leg higher than the other to keep the toes from dragging. I should say that the result is good as far as sensation is concerned, but negative as regards motion. The muscles fail to react to electricity." Another operation was at this time advised, but declined.

A further report on the case was courteously made by Dr. Richard R. Smith, of Grand Rapids, Michigan, August 31, 1903, seven years after operation. Dr. Smith writes as follows:

"There is a very decided atrophy of the anterior muscles of the leg. The patient is unable to flex the tarsus upon the leg in the slightest degree, nor is he able to extend the phalanges of the toes. There is complete paralysis of the tibialis anticus, the extensor proprius pollicis, the extensor longus digitorum, the peroneus longus and brevis. There is partial anæsthesia over the area supplied by the peroneal nerve."

The end result in this case is, then, a complete failure as regards motion, and this in the face of conditions which seemed to promise

a good result. The ends of the implanted fragments were carefully approximated, the sutures suitable, wound healing was perfect, and the fragment stayed in.

Summary of Twenty-two Cases of Grafting.

1. Case dismissed too early to record results.
2. Implanted segment came away necrotic.
3. Case dismissed too early to record result.
4. Negative at end of one year.
5. Sensation began to return in two months. Motion not recorded.
6. Suppuration. No improvement at end of two months.
7. Sensation good at end of five weeks. Motion indefinitely recorded.
8. At end of ten weeks an indefinite result is recorded.
9. At end of two years sensation "dull;" motion fair.
10. Motion and sensation (median) practically restored at end of six years.
11. Case reported too soon. (Sixteen days.)
12. At end of three months—ulnar. Sensation hardly complete. Motion indefinite.
13. At end of eight months. Motion fair. Sensation not noted.
14. Reported too soon to be of value. (Thirty-six hours.)
15. Sensation returned (fifteen days), but motion did not.
16. No result at end of two and three-quarter months.
17. No result at end of three years.
18. No improvement.
19. "Good" result at end of two years. (Median.) Sensation good; hand "lame, but useful."
20. One and a half years after operation (at end of four months patient froze hand, losing distal phalanges of first and third fingers). Sensation nearly normal. Hand used daily in work; fine movement of it impossible; some atrophy of muscles.[1]

[1] A recent letter from Dr. Peterson reports this patient as being at this time "perfectly well as regards the use of his hands."

21. Short time—leg had to be amputated—motion as well as sensation seemed to be returning. (Durante.)

22. Author's case. Reported at end of eight years. Failure.

As Peterson's paper is readily accessible the reader is referred to it for details. The writer has added to the 20 cases there recorded that of Durante and his own. These seem to give three "good" results (Cases 10, 19, and 20) and three which may be termed "fair" (Cases 9, 13, and 21). Twenty-two per cent. of the cases operated on may be said to have terminated in a satisfactory way, although in most of these the final result is not recorded with the detailed accuracy desired by one who would analyze them. One is forced to say that he questions the authenticity of some of the results accounted "satisfactory."

To this must be added the claims of various surgeons and experimenters that a piece of nerve has no intrinsic superiority as a graft to any other kind of organized tissue, and that given proper inolation of the divided ends from the surrounding tissue a bridge of any sort—a bundle of catgut loops, for example—is sufficient to permit of the regeneration of the nerve.

The writer in studying this branch of the subject concludes that nerve transplantation should be discarded.

FLAP OPERATIONS.

While several forms of neuroplasty have been proposed, the principle of all is the same, viz., a portion of the central or peripheral (or both) ends is partly detached, turned back and united to the other end of the flap. The principles underlying these operations, the technique, etc., have been fully described in textbooks and monographs. (De Forest Willard.)

The writer herewith briefly recapitulates the cases found by him in literature.

1. Létiévant, the deviser of the operation, experienced failure in his only case in human surgery. (See Chipault's *Operative Surgery of the Nervous System*, 1895.)

2. Dittel, another early operator, reported a failure (*ibid.*).

3. Wölfler (Nuegebauer, "Neurorraphie u. Neurolyse," *Beiträge z. klin. Chirurgie*, xv., 1895) did a neuroplastic operation after injury to the radial; the patient shortly disappeared from view.

4. Tillmanns' case reported in Chipault's *Operative Surgery of the Nervous System*—neuroplasty of median and ulnar nerves —successful.

5. Gleiss—same reference—successful neuroplasty of ulnar.

6. Brenner (*Wien. klin. Wochen.*, 1891). This case is remarkable in that operation was performed ten years after original injury. A flap operation was done upon the median nerve, with a good ultimate result.

7. Bobrow (1893, cited by Spijarny, original journal inaccessible). Excision of tumor involving sciatic in elderly man. Flap operation. Return of sensation and use of flexors of knee(?).

8. Giordano (*Clinica Chirurgica*, March, 1899). This surgeon in removing a tumor of the neck was obliged to resect 4 cm. of the vagus, the defect being overcome by a flap operation. Patient lived a year. For a short time after the operation he coughed at times.[1]

9. Von Bruns (*Allegem. Zeitsch. f. Psychiatrie*, Bd. lii., 1895–96). This surgeon operated upon an infant aged two months for congenital neurosarcoma of upper arm involving ulnar and median. No attempt to restore continuity of nerves until a year had elapsed, when, to overcome the paralysis, a flap operation was performed on both nerves. Under appropriate after-treatment there was excellent return of function in the domain of the ulnar and a partial return in that of the median.

10 and 11. The writer has not access to the cases of Lossen (Hueter-Lossen, *Grundrisse de Chirurgie*, 1896, 7 ed.) and Gundt (*Inaug. Dissert.*, Berlin, 1897). He gathers the impression that these cases were successful.

Of these 11 cases 5 are discarded as having been reported too early or as lacking in detail. Of the remaining 6, 2 were failures and 4 complete or partial successes.

[1] This case should really be discarded, for it is known that the vagus of one side may be resected with comparative safety.

IMPLANTATION OR ANASTOMOSIS.

The ten cases in which defects in the continuity of nerves were overcome in part by anastomosis are as follows:

1. Kennedy (in Vol. II. of Chipault's *Etat actuel*, etc.). In one case Kennedy implanted the central ends of the median and ulnar into the radial. Result negative.

2. Despres (cited by Dumstrey) implanted an injured median into the ulnar and obtained a "fine result."

3. Gunn (cited by Dumstrey) sutured the distal end of the ulnar (after removing a neuroma) into the median. Sensation returned; no report as to motion.

4. Sick (cited by Dumstrey) sutured the radial to the median; eighteen months later there was an excellent result as to both motion and sensation.

5. Neugebauer (sometimes quoted as Wölfler's case, cited by Dumstrey). After scar excision for contracture (bend of knee) peroneal paralysis was noticed. Anastomosis between the peroneal and (assumed) internal popliteal. Result negative eight months later.

6. Dumstrey (*loc. cit.*) implanted the ulnar into the median, and got partial return of motion and sensation.

7. Trzebicky (cited by Chipault's *Etat actuel*, etc.) sutured both ends of external popliteal to internal popliteal. Result satisfactory.

8. Trzebicky (vide supra) after resection median(?) for sarcoma implanted central(?) end into ulnar. Result satisfactory.

9. Trzebicky (vide supra) after resecting the ulnar for sarcoma implanted its central(?) end into the median. The primary result was satisfactory, but the patient soon died of metastases.

10. Codevilla (*Clinica Chirurgica*, 1900, Nos. 9 and 10). In a case in which the outer side of the knee was crushed, with the peroneal nerve involved in the scar, the peripheral end of the latter was grafted into the internal popliteal. No improvement followed.

The results may be considered encouraging in five or six cases out of the ten (50 per cent.).

RESECTION OF BONE.

Since it is a foregone conclusion that if a divided nerve can best be made to heal under favorable conditions of approximation, and that removal of a segment of long bone will permit this approximation and guarantee the restoration of nerve continuity, it will be seen that the only practical question involved is, When is it justifiable to resect bone for this purpose? It is not easy to answer this. The writer has found notes of 7 cases, in the majority of which the bones were injured in the original traumatism which involved the nerve. In one of Keen's two cases resection was undertaken for false joint following fracture. The references are as follows:

Keen (2 cases), in Chipault's *Etat actuel*, etc.; Rose and Carless (text-book on *Surgery*); and the older cases cited by Huber and other systematic writers (Lewin, Löbker, Bergmann, Wheeler).

SUTURE À DISTANCE.

This consists essentially of bridging a defect with loops of catgut, etc. The positive results of Glück and Ehrmann are sufficiently well known. Recently Keen (in Chipault's *Etat actuel*, etc.) has reported a case, with negative result.

TUBULIZATION.

Although this method is extensively quoted in literature, the writer is able to find but one case in which it has been used to favor the restoration of nerve continuity to the exclusion of other resources. To promote nerve regeneration along the natural paths surgeons have made use of barriers to prevent the fusion of nerve substance with the surrounding tissues. This is recorded many times in cases of simple nerve suture. So far as it refers to the principal method of securing continuity, the writer knows only of the case of Guelliot; this is cited by Ehrmann and others. As it resulted negatively, he judges that the theoretical operation of Van Lair has never assumed a definite status in practice.

GENERAL CONCLUSIONS.

Although correction of the evils resulting from a gap in the continuity of a nerve is a matter of great importance in a given case, it hardly seems possible at this time to say definitely what form of bridging should be employed. More cases, and especially cases recorded later and better, are needed. Neoplasty and implantation (anastomosis) are always available resources, and for the present it would seem that they should be preferred. Resection of bone may be advisable in selected cases. Transplantation of foreign grafts should be abandoned. It is hardly necessary to say that prognosis in an individual case should always be guarded and that repeated operations may be necessary.

FINAL RESULTS IN SECONDARY SUTURES OF NERVES.

By EMMET RIXFORD, M.D.,
SAN FRANCISCO, CAL.

The three following cases of secondary nerve suture have been under observation six, four, and two years respectively since the operation, and are presented as a small contribution to the surgery of the nerves:

Mrs. H., aged fifty years, in May, 1898, received a cut on the right wrist severing the tendon of the flexor carpi ulnaris and the ulnar nerve. The wound healed without suppuration. When seen by the writer ten weeks later there was complete ulnar paralysis of the hand, with atrophy of the thenar, hypothenar, and interosseous muscles; fingers flexed and rigid at first interphalangeal joints, deficient power of flexion of first phalanges, and partial ankylosis of elbow and shoulder from non-use.

Under ether the adhesions in elbow and shoulder were broken up and those in some of the finger-joints, but in others the adhesions were so firm that they could be broken only at the risk of fracture; in fact, one phalanx was fractured and the contracted skin of the little finger was torn. The ulnar nerve being exposed at the wrist, its bulbous proximal end was found separated from the distal by a considerable mass of scar tissue. The distal end was soft, but was not fibrillated nor otherwise macroscopically abnormal. The ends were cut off squarely, the central segment above the neuroma, and brought together with catgut, and the wound closed; plaster-of-Paris bandage applied with the fingers in extension and the wrist in flexion to relieve tension on the nerve.

The plaster was removed on the sixth day; primary union; passive motions of fingers made daily. On fourteenth day all support omitted, muscles stimulated by faradic current daily, and hot-water bathing and massage frequently for the inflamed joints.

Although there was some sensation on the ulnar side of the hand at the end of a week after the suture, there was no other evidence of return of function for several months. This return of sensation is more likely to have been due to anastomosis of other nerves than through the sutured ulnar. Gradually the atrophy of the thenar muscles became less, and within a year they moved normally.

At present, six years after the nerve suture, there is partial ankylosis of the first interphalangeal joints and Dupuytren's contraction of the fourth and fifth fingers; but the first phalanges can be flexed normally and the terminal phalanges can be extended as well as on the other hand. The thumb can be approximated to the little finger and ulnar side of palm, but adduction and abduction of the other fingers are wanting. Sensation is restored, but the ulnar side of the hand prickles when touched. The result, then, so far as motor nerve function is concerned is excellent, the deformity present being due to ankylosis.

Case II.—E. S., girl, aged thirteen years, in March, 1900, was caught in the timbers of a drawbridge and badly crushed. Both humeri were broken about the middle and both bones of one forearm. The right axilla was extensively torn open, exposing vessels and nerves and badly infected. In addition there were many contusions and abrasions which made satisfactory application of splints to the fractures practically impossible. There was besides complete musculospiral paralysis on the right side. After the wounds in the soft parts had healed, the fractures not being in good position, the left humerus was exposed and wired, and later the right.

At the time of the second operation, eight weeks after the injury, there was complete radial paralysis, drop-wrist, etc., with atrophy of the extensor group of muscles. The musculospiral nerve was

exposed and its proximal end readily found. The distal segment was found only after prolonged search and final lengthening of the incision downward, with identification of the nerve in front of the elbow-joint and following it upward. It lay wound around the humerus in front and to the inner side of the bone precisely opposite to its normal position. The distal part was shrunken, but not fibrillated. When the neuroma was cut off and the distal end freshened, the ends would not come together within three or four cm. after some considerable strain had been applied in the effort to stretch them. The humerus was then shortened some three cm. after mortising, and the nerve sutured without tension. The wound healed under a single dressing.

It was about six months before there was any very evident return of function, but after that the gain was rapid. The patient went from one clinic to another, receiving massage and electric treatment. Two years after the suture the case was presented to the California Academy of Medicine, and showed almost perfect restoration of sensation and motion, though the arm was noticeably smaller than the other.

At the present time, four years after the suture, the arm shows but very slight atrophy, measuring one-half cm. less than the other in circumference. But this might well be accounted for by hypertrophy of the other arm during the long period of disuse of the right. All the muscles supplied by the musculospiral nerve move, and with normal range of motion, but the power of extension is somewhat deficient. Tactile localization is perfect and individual muscles respond instantly under the will—*i. e.*, there is perfect volitional differentiation of the various movements controlled by the sutured nerve. There is no hesitation in extending the index finger, or raising the wrist or the third or fourth fingers on request.

Case III.—H. S., aged seventeen years, farm hand, in February, 1902, was run over by a harrow with ten-inch teeth, rolled over several times, and received many superficial bruises and a penetrating wound of the neck. A harrow tooth entered the hollow of the right ear, ranging downward, injuring the facial

FIG. 1.

Condition in repose two years after suture of right facial nerve.

FIG. 2.

Muscles of face in contraction, eye closed independently of other eye.

nerve. Dr. Lawhead, of Woodland, Cal., attended the wound, which healed without suppuration, and applied galvanic and faradic electricity for seven weeks, but without lessening of the facial paralysis.

When seen by the writer, eight weeks after the injury, there was complete facial paralysis, eye open, mouth drawn to opposite side, etc. The muscles of the face reacted well to the faradic current, but it was not possible to determine electrically whether the nerve was severed or merely bruised, or whether it was injured within or without the Fallopian canal. There was no interference with the sense of taste, however.

Exposing the mastoid process and lifting off the anterior part of the insertion of the sternocleidomastoid, the facial nerve was identified as it left the stylomastoid foramen and, followed downward, was found severed about 1 cm. beyond its exit from the canal. The distal end was found after prolonged search by first identifying its two principal branches in the parotid gland and tracing the main trunk backward. When dissected free the ends lay parallel directed downward and separated by nearly 1 cm. of scar tissue. There was slight enlargement of the proximal end. Section was made at points where the nerve seemed free of scar tissue, but it was so near the bone in the case of the proximal segment that the placing of sutures would have been extremely difficult. Accordingly, with a surgical engine the mastoid process was cut away, exposing the stylomastoid foramen and the aqueduct of Fallopius. The external wall of the canal was removed to such an extent that the nerve could be lifted out 5 or 6 mm. Sutures of catgut were then passed and the ends united squarely without tension. Primary union occurred, and patient left hospital on the ninth day. Faradic current was applied frequently, and at the end of three months there was barely perceptible power of contraction of the facial muscles. At four months the corner of the mouth could be raised, but the eyelids remained open.

At the present time, two years after operation, the asymmetry of the face has almost entirely disappeared. The intervals between the lids on the two sides are exactly the same when the face is in

repose, and both sides of the mouth are on the same level. The corner of the mouth can be drawn to the side of the injury together with the chin and tip of the nose, making a deep wrinkle in the cheek, and the eye can be closed independently of the other eye. The condition is still slowly improving.

Secondary suture of nerves differs from primary by the somewhat greater complexity of the operation, due to certain difficulties in technique consequent upon the presence of scar tissue, the presence of terminal neuroma on the proximal end, of degeneration of muscles, of adhesions of tendons, of trophic and other disturbances in the joints. Degeneration of the distal segment of the severed nerve has generally been regarded as making an important distinction between primary and secondary suture, but the recent researches of Ballance and Stewart show that there is very little difference on this ground, because the process of degeneration in the distal segment occurs so early after the solution of continuity, and that this degeneration occurs whether the nerve is sutured immediately or not. These writers make out an infiltration of leukocytes into the severed nerve within six or eight hours of the time of section of the nerve, segmentation of the neurilemma on the second day, and invasion of young connective-tissue cells on the third. Furthermore, clinical reports of so-called primary union of sutured nerves are rare and not altogether creditable, because the evidences of immediately restored function are only those of sensation, which may be explained in other ways. Again, in some cases reported this early return of sensation is only temporary. Generally after primary suture useful return of function occurs only after from two to four months, which is not materially different from the condition in secondary suture. Lewin, who collected some ten cases of primary and secondary suture of nerves from Mikulicz's clinic, found that the prognosis was not materially different in the cases of earliest suture from that in the later cases. Of five cases of primary suture collected by Oppenheim from Kiel only one had complete restoration of function, while three were merely improved. Larger collections of cases have shown pretty much the same thing, viz., that the

prognosis of secondary suture is little inferior to that of primary suture. Howell and Huber in 84 cases of primary suture found 42 per cent. successes and 40 per cent. improved; of 80 secondary, 38 per cent. successes, 50 per cent. improved. The statistics of Bowlby and Willard do not differ materially on this point. The only point, then, in which primary suture has a decided advantage is in the simpler operative procedure and in the better condition of the muscles and joints.

If, then, in a given case there is any good reason for delaying operation (such as infection of the wound) a reasonable delay will not prejudice the final result, provided that proper care be given the muscles and joints. Much can be done by systematic massage, passive motion, and faradism to prevent adhesions in the joints and degeneration of the muscles. It is important also during the interval of two to six months after suture, while regeneration of the nerve is taking place, that the care of the muscles and joints be not neglected.

The matter of infection is unquestionably of great importance in determining the prognosis, since suppuration favors the production of large amounts of contracting scar tissue interfering with restoration of nerve function. Since the prognosis in secondary suture is so little, if at all, inferior to that after primary suture, it would probably be more prudent in a given case, where there is doubt of securing primary union, to wait till neighboring suppurating wounds and abrasions are healed as well as the wound by which the nerve was cut before operating, rather than run the risk of necrosis and the deposit of large amounts of scar tissue about the nerve ends or of separation of the nerve ends from absorption of sutures. In other words, secondary suture with primary union is more apt to be successful than primary suture in the presence of infection.

The prognosis or estimation of final result must to a great extent be dependent on operative technique. The aim in all cases should be accurately to unite the severed nerve without tension and with the least possible traumatism. To secure the best results the nerve ends should be trimmed with a sharp knife rather than

with scissors (to avoid bruising) at points where the fibres are parallel—*i. e.*, in the case of the central segment above the terminal neuroma—and united with absorbable suture. The suture may penetrate the nerve bundle with little traumatism if a round needle or fine Hagedorn be used, but accurate approximation is best secured by fine sutures through the edges of the sheath. Bowlby suggested that the upper part of the terminal neuroma might be retained with advantage, because its firmer structure would hold sutures and resist tension better than the normal nerve; but the normal upper segment will hold sutures as well as the lower where there is no neuroma formed, and in general it may be said that tension should be avoided rather than resisted. Furthermore, there is probably some practical significance in this regard in the statement of Vanlair, that, after the repair of a nerve, if a second section be made through the cicatrix, regeneration will not follow.

In the above reported cases the neuromata were cut away entirely and the ends joined by two fine catgut sutures which passed through the nerve 5 to 8 mm. from the ends, for purposes of fixation, and two or three approximation sutures of fine catgut through the edges of the sheath. In the second case only was there a considerable defect of nerve tissue. The procedure of shortening the humerus was obviously the preferable one in this case, as the bone was already broken in two. On the other hand, however, the results of grafting, nerve splitting, tubulization, "distance suture," etc., have not proven to be as satisfactory as direct union, and it is therefore a question if in a given case it may not be preferable to shorten the bone rather than prejudice the nerve union as was first done by Löbker in the '80s (in the forearm), and as a number of others have done since. The procedure is one that has a definite though limited field of usefulness. Nerve stretching has been practised with advantage in cases of defects of moderate extent, but it should not be forgotten that there is objection to severe stretching, for it has been followed by degeneration of the nerve and with more or less permanent paralysis. The exact limits of usefulness of this procedure have not been determined,

though it is said that a defect of 3 cm. in most of the long nerves can be safely overcome by stretching. If it is proposed to stretch a nerve to overcome a small defect it would be well to adopt the suggestion of Bowlby to grasp the segments by their tips so that the necessary bruising may be limited to the portions to be cut away.

If the conclusions of Ballance and Stewart as to the essentially peripheral regeneration of severed nerve are substantiated they will have a marked influence on the prognosis of late suture. These authors, on the basis of rather extensive experiment and histological study, take strong position in the debate on the mechanism of restoration. They oppose the theory which has prevailed for many years that regeneration of axis-cylinders is by growth from the central segment only, that each axis-cylinder is a continuous process of a central cell or neuron, and that the distal segment plays a purely passive role in the regeneration. On the contrary, they claim that new axis-cylinders and medullary sheaths are produced in the distal segment from the cells of the neurilemma subsequent to the primary degeneration, whether the nerve has been sutured or not.

Clinically the process of degeneration in the distal part of a severed nerve leaves it smaller than before and flaccid, but it is not fibrillated nor is it absorbed; it never loses its structure, forming a mere band of scar tissue, as is the case with muscle, blood-vessels, etc., which have lost their function. The long intervals after injury, after which secondary suture has been followed by restoration of function, several months in Nélaton's case (the first secondary suture, 1865), five months in one case, fourteen years in another (Jacobson), is strong evidence in favor of the peripheral or local regeneration of nerves.

While it is stated (Kölliker) that restoration of function occurs earlier where the nerve has been sutured near its distribution than when it is sutured more centrally, the writer has been unable to find a case reported where function has returned in the muscles near the suture before it appeared in the muscles farther removed.

One of the most interesting phenomena on the border line of

anatomy and psychology is the restoration of volitional control of the various muscles supplied by the sutured nerve. In their normal anatomical relations the axis-cylinders are individually continuous from central cell to muscle plate and the path of efferent impulses is definite. After suture of a divided nerve, however, this direct path is of necessity interrupted, and after regeneration practically all of the axis-cylinders must be connected with foreign muscle plates and might be expected to lead volitional impulses astray. In the three cases here reported volitional differentiation is completely re-established. It is particularly noticeable in the case of the sutured musculospiral nerve. The patient can raise any one of the fingers without hesitation when he desires, and in the case of the sutured facial nerve can close the eye or raise the corner of the mouth independently as he wishes.

DISCUSSION ON THE PAPERS OF DRS. POWERS AND RIXFORD.

Dr. De Forest Willard, of Philadelphia.

Both in human surgery and experimental work on dogs I have practised several of the methods described by the essayists. In the implantation of an outside nerve, while the nerve is not itself preserved and does not form an actual bridge between the two divided ends, yet it certainly assists in the infiltration of new nerve fibres through the interposed connective tissue. I have demonstrated another important fact which I keep in mind in such implantations. We all know of the rapid growth and activity in the young. If we take an animal which is only a few weeks old the transplanted young nerve is much more likely to assist in bridging over the defect by the deposit of nerve fibres than is an older one, even though the nerve itself may disappear.

I have also found that decalcified bone tubes assist in the guiding of the deposit of these nerve cells between the divided ends.

In regard to the regenerative power of nerves, Dr. Rixford has alluded to the fact that a year later, perhaps two years later, we found that restoration of function has slowly taken place. This is not alone a restoration of transmission, but indicates also that other nerve fibres have vicariously taken up both motion and sensation. I have seen a notable instance of this power. A man, through a traumatism, lost eight inches of the median nerve. For a year afterward he had very little motion and sensation in the hand. About a month ago, eight years later, with great interest I examined his hand and found that he had full motion in his fingers, with sensation in all parts of the hand except a small portion of the palm.

Dr. Powers. In connection with Dr. Rixford's paper I would like to place on record a case in which a boy, aged sixteen years, suffered a stab wound division of the musculospiral at about the middle of the arm. Immediate suture was made in the usual way. A very large keloid developed, and the result as to both sensation and motion was absolutely *nil*. Seven or eight months after the first operation a secondary operation was done. The entire keloid was dissected out and was found to extend down to and between the ends of the fragments, involving the nerve at the seat of suture. The entire area was thoroughly resected, the nerve fragments freely stretched so as to admit of approximation, and suture made without tension. The keloid did not recur, and the result was perfect a few months after this secondary operation. That was some three years ago. I saw this young man recently and found his limb as good as it ever was.

OPERATIONS FOR PRIMARY CARCINOMA OF THE LIVER. REPORT OF A CASE WITH FREEDOM FROM RECURRENCE AT END OF SIXTEEN MONTHS.

By LEONARD FREEMAN, M.D.,
DENVER, COL.

Primary carcinoma of the liver is a rare affection, Hansemann finding it but six times among 258 hepatic tumors reported from the Berlin Pathological Institute, from 1880 to 1889, while Eggel computes, from various sources, that it occurs about once in every 2000 autopsies. In 800 operations upon the liver, Kehr encountered but one operable cancer.

It is either nodular or diffuse (carcinomatous cirrhosis), the former variety being much more common than the latter. The nodules may be single or multiple, large or small. According to most observers, primary carcinoma is more apt to exist as a single nodule, although there is a difference of opinion on this point.

The single primary nodule is alone amenable to surgical treatment. It may occur in any portion of the liver, but is usually found near the inferior border of the right lobe. It is generally met with during the "cancer age," but may be seen in younger individuals, a number of cases having been reported in patients under twenty years. It may arise from the endothelial lining of the bile-ducts or from the hepatic cells themselves, the latter origin being demonstrated by the secretion of bile in metastatic nodules. Metastases are common. There is almost always more or less coexisting cirrhosis of the liver. Whether the cancer arise from the cirrhosis or the cirrhosis from the cancer is still a disputed question.

There is a very close relation between tubular adenomata and primary carcinomata. They often coexist in the same tumor; and where a number of nodules are present, some may be adenomata and others carcinomata, while others are in a stage of transition. Some writers, such as Terrier and Auvray, class the adenomata as adenocarcinomata, their malignancy being indicated by the metastases which frequently take place.

The only hope for permanent cure of primary carcinoma lies in early operation; but the diagnosis at this time is extremely difficult, owing to the small size of the tumor and the frequent insignificance or even total absence of symptoms. Generally, when the tumor is large enough to be felt from without, or when icterus or ascites has appeared, it is too late for an operation to be of service, except for purposes of palliation.

Statistics are difficult to obtain, especially with the limited literature at the writer's command, and I shall make but little attempt to present them. In 1901 Terrier and Auvray collected 52 operations for hepatic tumors. Of these 9 were primary carcinomata and one secondary. Ten of the 52 cases died—19⅔ per cent. Local or general recurrence has been the rule, but there are some exceptions which afford encouragement for further efforts. For instance, one case (Schrader) was well at the end of seven years and another (Terrier) at the end of five months. A favorable case reported by Lücke, in 1890, however, was probably a gumma (Kehr), and should not be considered in this connection.

METHODS OF OPERATING.

There are two principal methods of operating, both of which have numerous advocates—one in which the stump of the liver is sunk in the peritoneal cavity, and the other in which it is fastened in the wound, thus rendering it extraperitoneal, as was formerly done in hysterectomy. Owing to recent improvements in technique the former procedure is as free from danger of hemorrhage as the latter, and is certainly preferable from the standpoint of asepsis and rapid and satisfactory convalescence. In

addition, there are cases in which the liver cannot be mobilized sufficiently to permit of secure extraperitoneal fixation, even by attaching it to the peritoneum alone—the "funnel method" of Riedel.

In case the extraperitoneal method is adopted, however, there are three ways of proceeding:

1. The operation may be done in two stages. In the first the portion of the liver containing the tumor is sutured into the abdominal wound, where it is permitted to remain until firm adhesions occur, and in the second the tumor is removed. This suggestion of Tillmanns, it may be remarked, has not been generally adopted.

2. The liver may be fastened in the wound by sutures, or possibly by needles passed through its substance, and surrounded by an elastic ligature, which remains until gangrene appears, when the dead part, including the tumor, is cut away (Lücke, Terrillon). It would seem, however, that the danger of sepsis during this time must be considerable, to say nothing of other objectionable features.

3. After securing the liver in the incision the tumor may be excised at once.

Numerous suggestions have been made regarding the control of bleeding during the operation and subsequently. No one of them is entirely satisfactory, but several are sufficiently so to justify their use. The principal methods are as follows:

Incision. No special form is indicated. It can be vertical or transverse, along the costal margin, or curved according to Bevan; but it should be so situated as to expose the tumor to the best advantage and afford plenty of room. It may occasionally be necessary to resect the cartilages of the eighth to the eleventh ribs (Lannelongue), or even to turn up a flap from the chest wall (Micheli), or mobilize the liver by dividing the ligaments which suspend it (Langenbuch).

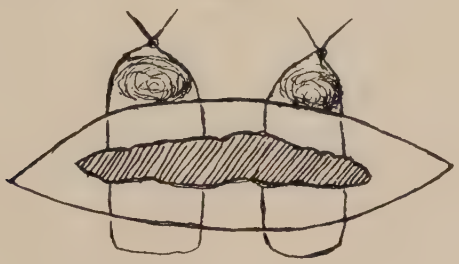
Hæmostasis. After exposing the tumor, the remainder of the operation consists practically in the control of hemorrhage, the actual excision of the growth usually presenting no serious difficulties. The fear of uncontrollable bleeding has greatly retarded the advancement of hepatic surgery, and it is only within the last

few years that methods have been devised which have inspired a reasonable amount of confidence.

Experience has shown that no matter what precautions have been adopted, it is wise to reinforce them with ample gauze packing, especially when the cut surface of the liver is replaced within the abdomen. Failure to do this has led to disaster from delayed hemorrhage.

(*a*) *Temporary Hæmostasis.* 1. Constriction of an entire lobe of the liver by an elastic ligature. This is particularly applicable to a movable left lobe, although Israel has succeeded in applying it in a single instance to the right lobe during the removal of a sarcoma in a child.

FIG. 1.



2. Digital compression furnished by assistants. This can be resorted to in favorable cases only—where the tumor is pedunculated or fairly well isolated near the border of the liver.

3. Provisional ligature of the vessels in the hepaticoduodenal ligament. This was suggested by Langenbuch, but I am not aware that it has been employed by others.

4. Parenchymatous injections of adrenalin chloride (Gualdrini). If this has any appreciable effect, it can be upon the smallest vessels only, and therefore its value seems questionable.

(*b*) *Permanent Hæmostasis.* 1. The liver may be sutured into an incision parallel to the costal margin in such a manner that the edges of the wound exert sufficient pressure to check bleeding (Chapot-Prevost). This is perhaps best accomplished by means of several mattress sutures passing through the tissues at the border of the ribs, deeply through the liver, and out through the

abdominal wall below. They are then returned in reverse order and tied over compresses at their points of insertion. (Fig. 1.)

2. Sutures of heavy silk may be inserted through the abdominal parietes, passed under the bleeding points in the liver, brought out again, and tied on the surface of the skin (Ullmann).

3. The actual cautery. This has often proved unreliable, and should not be trusted to alone, although it may be valuable in checking mere oozing.

4. Cauterization with steam at 70° C. (Caponago) or heated air (Abramowitsch). Although both these methods have been highly spoken of, they are probably no more effective than the actual cautery, and not nearly so convenient. They are not frequently employed.

5. Compression by gauze is very valuable as an adjunct to other procedures, and should always be resorted to. In order to hold the gauze securely in place it may be advisable to fasten it with sutures (Hochenegg), or even to sew it between the edges of an incision.

6. Immediate suture of an incised wound is ideal, but seldom practicable.

7. In order to prevent ligatures from tearing through the friable substance of the liver, an accident much feared before the experiments of Kurznezow and Pensky, Delbet strung upon filaments of catgut a number of hollow sections of decalcified rabbit bones, while Segale recommended tubes of ivory or ebony, and Cecherelli and Bianchi plates of whalebone. These ingenious devices are, however, inferior to others which are less complicated and troublesome.

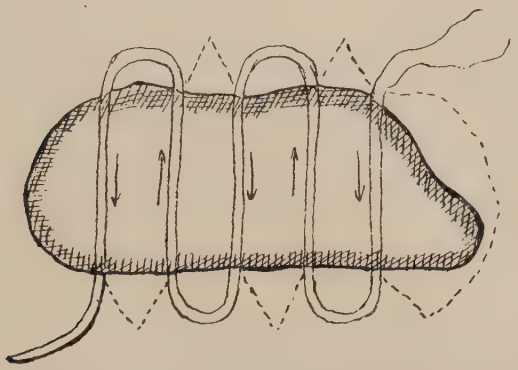
8. The use of permanent forceps or clamps is often of great service.

9. The elastic ligature, especially in pedunculated tumors, has had many adherents. It is generally used extraperitoneally, although not necessarily so. If the pedicle is large the ligature may require tightening from time to time (Lücke), and care must be used to prevent too rapid cutting of the tissues.

10. It has been suggested that bleeding may be checked by stitching omentum over the raw surface. Although this may

occasionally be of some service, it can have no extended applicability, on account of its unreliability and the amount of time consumed.

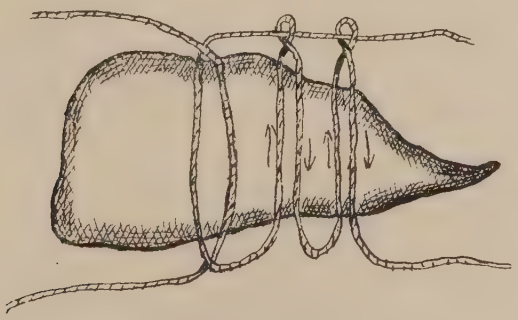
FIG. 2



The continuous lines represent a continuous double thread passed backward and forward through the liver by means of a blunt needle, so as to form a series of loops. By dividing the loops, separate ligatures are obtained, which are tied as indicated by the dotted lines. (Terrier and Auvray.)

11. A method which has attracted much attention was presented by Kurznezow and Pensky in 1886 (Fig. 2), and modified

FIG. 3.



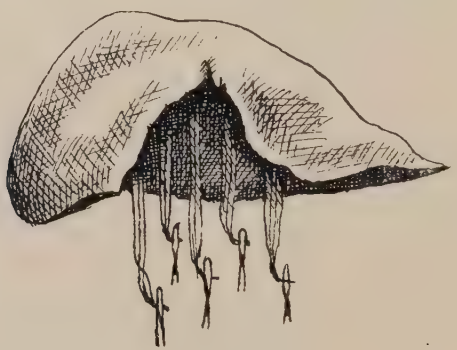
Terrier and Auvray.

by Auvray in 1897 (Fig. 3). It depends upon the principle that when a ligature is tied *tightly* about a section of liver not too large, the parenchyma gives way, but the contained vessels are

gathered into a bundle and held firmly. (Fig. 4.) The procedure is certainly effective when properly carried out; but it requires time and care, and the somewhat elaborate technique is usually forgotten when needed, which is apt to be unexpectedly.

12. The liver substance surrounding the tumor may be easily ligated with narrow strips of gauze pulled through with long, blunt forceps, as suggested by W. Müller, who treated the stump, however, extraperitoneally. The writer's method of employing these strips intraperitoneally is detailed in the report of his case.

Fig. 4.



Terrier and Auvray.

13. In some instances, either alone or in connection with other procedures, the hepatic vessels may be seized with forceps, pulled out from the cut surface, and easily ligated. Experiments have shown that they will stand a traction equal to 750 or even 850 grams.

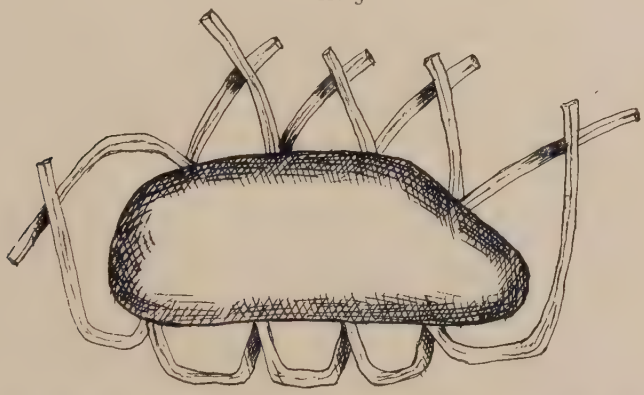
REPORT OF CASE.

A well-developed, muscular locomotive engineer, aged twenty-seven years, had been annoyed for a year or more by heaviness and moderate pain in the region of the gall-bladder, with occasional exacerbations accompanied by slight jaundice and marked indigestion. Examination revealed a hard, irregular tumor, apparently about the size of a walnut, although the patient stated that it sometimes became larger and more tender. It occupied

the position of the gall-bladder and moved up and down with respiration. A diagnosis was made of a gall-bladder tightly filled with stones, although this was done with reservation, because of the mildness of the symptoms in spite of the size, irregularity, and hardness of the tumor.

Operation (January 20, 1903). A longitudinal incision through the right rectus revealed a hard, nodular tumor of the left lobe of the liver, just to the left of the notch. It was the size of a large fist, buried almost completely in the substance of the organ, and without a pedicle. The greater portion of the growth lay beneath the free hepatic border, so that a small portion only could be felt by abdominal palpation. There were extensive omental adhesions, but no enlarged glands, and the remainder of the liver was free from involvement as far as could be detected. The gall-bladder was normal.

FIG. 5.



After enlarging the incision, it was decided to isolate the tumor by means of ligatures formed from narrow, folded strips of gauze, such as are found in every operating-room. The liver was perforated with long, blunt forceps and the strips pulled through—at first two strips, and then, through each successive hole, an end of the previous strip together with a fresh one. A series of loops were thus obtained, each one enclosing a considerable amount of tissue. (Fig. 5.) These were slowly and forcibly tightened and tied, thus effectually compressing the liver, but not cutting

it as do ordinary sutures. Hemorrhage from the perforations was prevented by the presence of the gauze.

The tumor was then removed by cutting through normal liver tissue with a scalpel, no bleeding following the section except from a single vessel not included in the ligatures. After sinking the stump in the abdomen it was packed around with gauze, the ends of which, together with the ends of the strips, being brought out through the partially open wound.

The progress of the case was uneventful except in one respect—the removal of the gauze ligatures. The knots being buried deeply in the wound, they could not be untied or even cut with certainty. After some difficulty several strips were finally extracted; but the others resisted all efforts until bands of rubber were attached to them so as to exert constant traction, when they came out promptly and easily and without pain. At another time I should be inclined not to tie the strips, but merely draw them tight and clamp them with forceps, or tie them with catgut, thus admitting of comparatively easy extraction; but in case a strip should stick, elastic traction could still be employed.

The patient left the hospital in about six weeks completely recovered. On May 18, 1904, about sixteen months after the operation, he was perfectly well, with no signs of recurrence, no disturbance of any kind, and doing regular work on his engine.

PATHOLOGICAL REPORT (DR. J. A. WILDER, OF DENVER).

Gross Appearance. The free surface of the specimen is irregularly nodular in appearance, the nodules being smooth, rounded, and elevated, and merging into each other.

On section, the tissue which forms the greater part of the specimen, cuts with considerable resistance, being very tough and fibrous, and light in color, in marked contrast to the liver tissue proper. In several places a sharp line of demarcation can be seen between the neoplasm and the liver substance.

Microscopic Examination. Specimens hardened in formalin and alcohol, embedded in celloidin, and stained with the usual

stains. Sections were made from blocks taken from the periphery of the neoplasm and from its central part, as well as from blocks including both liver tissue and neoplasm. Sections from the peripheral portion consist of a well-marked stroma of dense connective tissue which forms irregular alveoli in which the cellular material, which is of the glandular epithelial type, is compactly arranged. In some places the cells are so arranged as to give the appearance of atypical and irregular gland tubules, the cells approaching the columnar type and being arranged in several layers. No basement membrane can be seen. In most fields the alveolar arrangement with the cells completely filling the spaces is most conspicuous. In some places the cells are arranged in long columns which are surrounded by the connective tissue.

The cells are large and have large round or spheroidal nuclei that take the stain with moderate intensity and contain distinct nucleoli. The cytoplasm is present in considerable amount, its periphery in some of the cells being distinctly outlined, but in the majority indistinctly, the cell bodies appearing to have coalesced.

The majority of the cells that can be accurately measured are from 16 microns to 22 microns in diameter, their nuclei measuring from 7 to 12 microns. Sections from the blocks in which both liver tissue and neoplasm were included show a broad band of connective tissue between the two which has been infiltrated in various places by the tumor cells. The liver cells differ very materially from those of the neoplasm in general appearance, staining reaction, arrangement, and regularity. They show a moderate amount of parenchymatous degeneration. The stroma is abundant and consists chiefly of adult fibres of connective tissue, giving the picture of scirrhus in many places. In some parts the stroma is infiltrated by collections of lymphoid cells. The vascular supply is rather poor, but a few vessels with well-developed walls are present in the connective tissue. The stroma contains also a few apparently normal bile-ducts. An effort at encapsulation by dense connective tissue appears to have been made

at the periphery of the nodules, but this tissue had been infiltrated n many places by the epithelial cells. The distinctly adenomatous appearance of the growth in some places and the characteristics of the epithelium present are suggestive of the possible origin of the neoplasm from the bile-ducts.

Histological Diagnosis. Adenocarcinoma.

DISCUSSION.

Dr. W. W. Keen, of Philadelphia.

My experience with tumors of the liver has been limited to three cases. The first was an adenoma, the second an angioma, and the third a carcinoma, there being in each case a single tumor embedded deeply in the tissue of the liver at the anterior border.

Judging from my experience in these cases the whole question of the operative surgery of the liver practically is one of hæmostasis. It so happened that in these three instances I adopted three different methods.

In the first case—the adenoma—I divided the normal liver substance just outside the limits of the tumor by means of the Paquelin cautery, and I cannot speak too highly of it. I was able in this case, by making small cuts repeatedly, to discover the large vessels of the liver readily before they were cut through by the cautery, and in each case to ligate them by means of catgut without any trouble, with practically no hemorrhage, and then to suture the flaps thus made as if they were amputation flaps.

In the second case I adopted a method which I do not think I should adopt again, namely, I incised the liver partially, so as to make an artificial pedicle of the tumor, tied around it an elastic ligature made of rubber tubing the size of a lead-pencil, and treated this extraperitoneally. Although no sepsis followed, and the patient recovered without trouble, yet, at the same time, I should not adopt it again because of fear of possible infection from the strangulated tissue.

In the third case I used the knife, and was not as well satisfied with it as with the Paquelin cautery. It answered the purpose, however, and the patient recovered from the operation.

As to the method adopted by Dr. Freeman, I confess I should think the cautery was much more desirable. Buried sutures (as they practically were) of strips of gauze in the liver tissue may be awkward to get rid of later. I should think by means of the cautery the vessels could have been discovered and ligated as they were reached.

The first case of adenoma I heard from several years later, and she was perfectly well.

The second, one of angioma, recovered perfectly, and was well some months afterward, but I do not know the later history.

The third, one of carcinoma, recovered from the operation, but I have no doubt succumbed from recurrence, which was in progress when I last heard from him.

Dr. George Tully Vaughan, of Washington, D. C.

I want to add to this list of cases one case of excision of tumor of the liver which occurred in my own practice. It was a gumma, rather small, about the size of half a hen's egg, possibly, involving the left lobe of the liver near the anterior margin. It was removed by the knife, and hæmostasis established by catgut sutures, the edges of the liver sewed together, and the patient made a good recovery.

Dr. L. L. McArthur, of Chicago.

I think one point should be emphasized in the consideration of these cases, and it is this: clinically, we cannot always be sure we have to deal with primary carcinoma of the liver. On coming down apparently to a solitary nodule in the liver, with no other evidence in the neighborhood or in the clinical history to lead us to believe there is elsewhere a similar growth, we may be induced to remove that growth. Such has been my experience. I well remember a case of pulsating tumor in the epigastrium, which was difficult to diagnose between carcinoma of the stomach and tumor of the liver because of the vomiting which it provoked. The matter was carefully considered, and the probability of a tumor of the liver proven by operation. The knife was used to resect the liver, hæmostasis being established by means of a Mikulicz sac quickly interposed and packed with gauze. The patient recovered from the operation, but died later from other carcinomata that were shown to have developed in the hilus of the liver, which at the time were not found.

In a second case a tumor of the liver was excised from the same position. There was considerable difficulty in deciding whether the tumor invaded the liver from the stomach or the stomach from the liver. Resection of the stomach and liver was made, packing against the resected liver with Mikulicz's sac was sufficient to control hemorrhage. It is now three and one-half years since the operation was done, the patient is alive, and continuing his duties as hospital orderly. Microscopic examination of that growth leads one to the question as to whether these tumors are adenomata or carcinomata, and in this particular case the late Dr. Fenger, who saw the specimens presented at the Society, pronounced them undoubtedly carcinomata, because of having no capsular outline between the liver substance and tumor proper. He predicted early death of the patient; but, as I have said, four years have elapsed, and the patient is still at work.

Dr. Alexander Hugh Ferguson, of Chicago.

I wish to say a few words in regard to the control of hemorrhage. I have had occasion to do partial hepatectomy a number of times in con-

nection with hydatids of the liver. There, however, hæmostasis is comparatively easy, but sometimes we have to attack healthy portions of the liver. In one case of primary embryonal adenosarcoma of the kidney which involved the spleen and a portion of the left lobe of the liver, at one sitting I removed the tumor, the entire spleen, and about two-and-a-half by three inches of the left lobe of the liver, with absolute control of the hemorrhage. Large mattress stitches of catgut put through and through, interlocked, and tied before cutting through any of the liver tissue, then taking scissors or knife and cutting off the diseased portion, usually control the hemorrhage, but occasionally the application of the actual cautery may be employed in addition to the sutures. I think it is better to drain all these cases.

Dr. E. Wyllys Andrews, of Chicago.

I would like to ask Dr. Freeman to tell us in closing the discussion whether biliary fistula is a common complication of these operations.

Dr. Freeman. As regards biliary fistula, in going over a good deal of literature I have seen but one or two references to it.

As to the use of the thermocautery, in spite of Dr. Keen's favorable experience, most men who have tried it speak against it, saying it is not reliable for the purpose of stopping hemorrhage in connection with the liver. I should not care to depend upon it.

With reference to the use of gauze, most of us forget the complicated stitches and sutures recommended in text-books, while gauze is always convenient and its use simple. It is not difficult to get it out if it is properly applied, and it can always be removed with elastic bands if necessary. There is a further advantage in operating in a perfectly dry field and with full control of hemorrhage.

THYROIDECTOMY FOR EXOPHTHALMIC GOITRE. BASED UPON FORTY OPERATED CASES.

By C. H. MAYO, M.D.,
ROCHESTER, MINN.

The subject of goitre is still an unsettled question, at least in many of its phases, although there have been written over fourteen hundred articles and books upon the subject. While it is quite probable that nothing new may be presented, still discussion develops suggestions which may prove of benefit at this time, as our more advanced knowledge of the lymphatic system and the glands, both with and without ducts, renders the subject of internal secretions of exceeding interest.

We will not enter into a description of the anatomy, pathology, and symptoms of Graves' disease, but, to avoid much repetition, will assume at once, for the sake of brevity, that those interested understand what is meant by the disease in question.

These patients present themselves to the physician for the relief of symptoms which he attributes to exophthalmic goitre, or they come to have a confirmation of diagnosis, and relief if possible. While there are many symptoms of Graves' disease, more or less of which may be present, the one symptom most common to all is tachycardia, without other known cause, and with this are usually associated the goitre and the prominent eye which are so characteristic. These two symptoms, from their late or non-appearance, have often delayed the early diagnosis of the disease. A not uncommon type is one in which the symptoms of Graves' disease are suddenly grafted upon a patient who has had colloid cystic goitre for some years. It is also true that patients without as well as with goitre seem at times to develop very

many of the symptoms of exophthalmic goitre, and yet recover very soon, often without any special treatment.

We must assume that there may be a combination of causes for exophthalmic goitre, accepting the gastrointestinal toxæmia of certain medical writers as a part with the thyroid element the major, and the nerve theories as not least in the combination of circumstances. To read the medical side of this question it would seem that the internist and surgeon are gradually drifting apart. The internist attempts to convict the surgeon with his own reports of multiplicity of operation, large mortality, and the not infrequent failures, and lauds the medical, hygienic and diathetic treatment. Judging from personal knowledge, it is probable that most of these cases who finally see the surgeon, have already run the gauntlet of all known remedies for the disease, and usually at the hands of several practitioners. We think that it would be rare, indeed, for a surgeon who was capable of making one of the operations for its relief to recommend operation at the inception of an attack of Graves' disease, unless it were possibly a case grafted upon an already goitrous patient.

Practically all surgeons have passed years in general practice and have seen the ordinary exophthalmic patients improve under medical treatment, electric treatment, no treatment, and the mental suggestion of Christian Science. We all know that some cases resist all efforts at relief. What shall be done for them?

From the experiments in blood pressure, shock, and resuscitation carried out by Dr. Crile, it would seem that the blood pressure is maintained by the vasomotor system as a direct nerve type and by the internal secretions as a blood type, acting upon the vessels even when the head is removed. From what little knowledge of the internal secretions we now possess, this equilibrium of the blood pressure must be in great part sustained by the opposing action of the secretion of thyroid and suprarenal glands. One of the functions of the suprarenal gland secretion serves to greatly increase blood pressure, and through its action upon the capillaries it greatly reduces all peripheral circulation. While a tension is

occasionally noticed in the pulse of Graves' disease, it is more often low, especially when the disease is active.

Were it possible that these secretions in effect served to maintain an equilibrium of certain blood elements, it would readily explain the effects of an excess of thyroid in one case and an excess of suprarenal in another. Thus the loss or absence of thyroid tissue in the young is followed by cretinism from the unobstructed action of the suprarenal glands, contracting all peripheral capillaries and preventing growth and development. In adult life the same conditions cause intellectual degeneration and myxœdema. While it is contended that the thyroid secretion does not, when given to the system, cause Graves' disease, it is certain that some of the prominent symptoms may be thus produced. We must admit also, that the thyroid employed is changed and given in an abnormal manner as compared with the constant delivery of the internal secretions by means of the lymphatic system acting in great part as ducts. The hard and practically dry gland of this disease as compared with the juicy colloid cystic variety would indicate unusual activity as well as delivery of the contents of the acini, while in the colloid goitre the secretion may be retained at least in part; and even in cases without goitre, a careful examination usually discloses a small unilateral or bilateral tumor which lies deeper but is firmer than normal.

What has been done surgically? First, exothyropexy, or the permanent exposure by incision of the thyroid lobes lifted external to the skin. This operation is now rarely performed. Second, ligation of the thyroid arteries. Third, operations upon the cervical sympathetic ganglia after the suggestion of Edwards, and developed by the work of Jaboulay and Jonnesco, for the relief of several diseases. Fourth, thyroidectomy, which we will discuss later. Fifth, the apparent psychological effect of operations upon distant parts of the body we will not consider.

It has been our fortune, or misfortune from its difficulties, to operate upon several cases of cervical adenitis which had been exposed many times to the *x*-ray. It was noted that the lymph system was greatly sclerosed. As this was in line with the reported

action of the *x*-rays upon glandular activity, we applied this treatment to ten cases of very marked exophthalmic goitre during the past year, to first reduce glandular activity, and, second, reduce absorption by its possible effect upon the lymphatics. While I would not as yet say that any of these cases are cured, they have certainly been markedly benefited: first, in the general nervousness; second, in tremor of the muscles; third, in tachycardia, and third, in the exophthalmos. The benefit is sufficient to soon give this method a place in the treatment of Graves' disease or at least make it a preparatory treatment to a prospective surgical method at a later period.

The symptoms were well developed in all; all improved. The three cases presenting the most marked symptoms had been under observation from one to two years at the beginning of *x*-ray treatment, having materially improved, but reached a stationary condition under medical treatment and rest. All three had marked exophthalmos, choreiform jerking, and pulse from 120 to 140. In the three cases choreiform jerking disappeared; exophthalmos markedly diminished in one, improved in one, and almost disappeared in the third. Pulse—patient at rest—68 to 70 in one, 75 to 85 in one, and 90 to 98 in the third. Circumference of the neck taken around the most prominent part of the goitre diminished from $\frac{1}{2}$ to $1\frac{1}{4}$ inches. One lost fifteen pounds, one gained ten pounds, and one gained forty-nine pounds. Two cases of well-developed symptoms, but no exophthalmos, so far recovered that a diagnosis would be impossible at the present time. We still have confidence in belladonna in improving the tachycardia and nervous symptoms preparatory to operation in certain cases of doubtful operative risk.

Curtis' report of Kocher's operative cases in this line gives twenty-nine cases of ligation of the thyroid vessels, with one death, and thirty-eight of partial thyroidectomy with three deaths. Our experience is from 128 operations upon the thyroid gland, with eight deaths; of these one followed the removal of a cancerous thyroid from collapse of the trachea, one from pneumonia in colloid goitre, and the other six deaths were in the exophthalmic cases, of

which there were forty. Two of these deaths were of patients who should not have been operated upon, as their condition was so aggravated as to almost class them as moribund previously to operation, one dying upon the table. All had received prolonged medical treatment. During the past year two such cases were seen with regard to the advisability of operation, but, with a knowledge born of bitter experience, both were refused. One died in a week, the other lived a few weeks, but both deaths were medical. In the last twenty-five cases operated for exophthalmic goitre there were but two deaths. The shortest duration of the disease was five months, and the longest several years.

The anæsthetics have been cocaine, chloroform, and ether, preceded twenty minutes by one-sixth grain of morphine hypodermically. Ten cases were completed under cocaine infiltration, two cases required, in addition, chloroform before completion. We choose cocaine for some of the worst types of nervous cases, especially with a rapidly fluctuating or irregular pulse, but can see no difference in the character or degree of shock or thyroidism in local or general anæsthesia. Cocaine is also used if one lacks confidence in the anæsthetist. Our preference is for ether. During the anæsthesia, should much mucus accumulate in the trachea and bronchi, the patient is allowed to come out of the anæsthetic sufficiently to clear the throat, and the chloroform is substituted. The Kocher collar incision is used and a complete exposure of the gland made, cutting everything which impedes access to it. One-half of the gland, and possibly the isthmus, is taken.

According to Dr. Sifton, the anatomist, of Milwaukee, the right recurrent laryngeal nerve closely approaches or is in contact with the right inferior thyroid artery, while on the left it is over one-fourth of an inch back, and an effort would be required to injure the nerve upon that side. The method of removal by extirpation is the rule, as in these cases there is usually very little capsule, and enucleation is out of the question. What can be left of the posterior capsule is a great protection, especially upon the right side, for the reasons stated above.

Thyroidism of some degree is common. It is not from rough

handling of the unbroken tumor and forcing secretion into the veins. If so, it would be equivalent to hypodermic injection into a vein with immediate effect, when in reality it comes after some hours,-and is due, apparently, to absorption of the wound serum, with some thyroid secretion in suspension. Thus many of the symptoms of Graves' disease are not uncommon for the first few days following the removal of ordinary colloid cystic goitre. For this reason we drain exophthalmic goitre wounds as freely as we would a septic process. If there is anything which increases absorption in wound or gland it is loss of blood. Therefore, should the patient unavoidably lose a quantity of blood, every effort should be made early to replace the quantity lost, or more, by salt solution. This is true also of operations upon exophthalmic patients who are operated upon for other necessary surgical conditions. We have had one patient afflicted with Graves' disease die four days after the removal of a twisted pedicle ovarian cyst, with all the characteristics of a death following the removal of the goitre, excepting the delay for two days of the severe symptoms. For the relief of thyroidectomy and increased tachycardia, suprarenal extract has a marked effect, but seems to be somewhat difficult of permanent control. The benefit obtained from atropine and morphine is often very satisfactory.

We do not wish to be understood as objecting to operations upon the cervical sympathetic, as it is very certain that good results are thus obtained; still such operations have considerable mortality and also the same disagreeable symptoms often following extirpation. We have, therefore, chosen to work directly upon the organ we have considered affected in operating for the relief of this condition. While the results of thyroidectomy, could we eliminate more of the hopeless and yet operate upon medium and severe types of Graves' disease, would justify the operation and compare favorably with those obtained by other methods.

Our own cases show marked improvement of all who survived the operation. Of these 50 per cent. made a very early recovery, especially of the severe symptoms—tachycardia, nervousness and tremor—25 per cent. did so after several months, and 25 per cent.

were improved, yet suffer from irregular recurrence of some of the major symptoms.

The improvement noted was first a relief of nervousness, the irregular twitching and jerking, not unlike chorea, next the tachycardia and the tremor, while the exophthalmos, if at all marked, seemed last to disappear, although relieved in some extreme cases.

Our rules concerning the cases of Graves' disease which come to us for operation are to operate, if their condition is fair, but, if the pulse is from 130 to 160, or if it suddenly fluctuates in tension and rapidity, if there is anæmia with swelling of the feet, the patients are placed upon the belladonna treatment for some days. The more severe types are also given *x*-ray exposures in addition, which is continued from two to six weeks.

Of the six deaths, one occurred upon the table as the final skin sutures were being placed; two occurred at from fifteen to eighteen hours after operation, and three deaths occurred at from twenty-four to seventy-two hours. They suffered from an exaggeration of the previous symptoms: the jerking, tremor, increasing rapidity of pulse, and exophthalmos. The degeneration of the heart muscle will account for some of the sudden deaths as pointed out by Prof. Fenger, while the absorption of thyroid, shock, anæmia, and general nerve exhaustion will account for most of the other deaths which are not due to the anæsthetic.

DISCUSSION.

Dr. A. J. Ochsner, of Chicago.

This splendid paper should certainly receive a good discussion, because it contains the facts that relate to the surgical treatment of Graves' disease. In the first place, the point made about the absolutely hopeless cases should be considered, because everyone who has repeatedly operated on patients suffering from Graves' disease has learned to avoid certain cases that seem to have practically no resistance. I have lost one patient after thyroidectomy for exophthalmic goitre, and this man had previously suffered from chronic alcoholism. The operation was followed by delirium tremens. It was foolish to attempt an operation in a case which was burdened to that extent. The operation was performed, however, because some of the very bad cases previously had made very satisfactory recoveries. But I believe such cases should not be subjected to operation, for the reason that there is not sufficient resistance, and with this burden of alcoholism it was foolish on my part to have operated.

I believe that the absorption of thyroid substance from the surface of the wound is of great importance, but the pressure which is made during the operation is of equally great importance. In my own cases, before this point was brought out some years ago, I had two deaths.

The difference between operating upon these cases with the use of cocaine and with general anæsthesia does not come from the fact that general anæsthesia is more dangerous to the patient in itself, but from the fact that when the patient is under general anæsthesia one is likely to manipulate the gland to a greater extent. He is liable to squeeze the secretion of the gland into the circulation, and it was in those cases accompanied by high temperature that death occurred suddenly. In the cases in which I have not manipulated the glands to any great extent, death has not occurred.

Dr. Emmet Rixford, of San Francisco.

Dr. Huntington and myself have operated on twelve or fourteen cases of exophthalmic goitre without mortality. Believing that the greatest danger of operation in these cases is in the anæsthetic, we have operated invariably under local anæsthesia obtained by means of a weak solution of cocaine. Personally I have preferred the transverse incision, cutting, as Dr. Mayo has suggested, practically everything that covers the gland.

As to drainage, I would say that I have drained about half of my cases, and have been unable to see any marked difference in regard to the subsequent so-called thyroid symptoms. I know that Kocher drains his cases as a systematic procedure. Nearly all of the cases operated upon by Dr. Huntington and myself have shown some rise of temperature afterward, and some degree of the other thyroid symptoms. It seems to me, from this limited experience, that the thyroid symptoms occur much more uniformly in the cases of so-called primary exophthalmic goitre, as distinguished from secondary, where the Basedow symptoms are implanted upon a pre-existing goitre. In the latter class of cases relief is almost immediate after the removal of the offending goitre, which is apt to be a thyroid adenoma.

Dr. Alexander Hugh Ferguson, of Chicago.

This is a subject which should receive the attention of every surgeon. We have all had experience with it. We have all had our successes and failures. An important point to decide is when and when not to operate. Sometimes cases will be brought to us *in extremis*. The disease has been long standing, and death is inevitable. We operate, and the case gets well, and we are astonished at the result. We operate again on other cases in which the disease seems stationary, and yet the patients die from acute thyroidism, so that a distinct line of when and when not to operate, and what cases to select, is not clearly defined, according to my opinion. I have irrigated all of these cases, before draining, with some antiseptic solution, iodine in preference. I have used the electrothermocautery with the idea of controlling hemorrhage and preventing absorption of thyroid juice. This may be of some use in forestalling thyroidism.

Dr. J. Collins Warren, of Boston.

I have had some experience in operating for goitre. In regard to the technique of the operation, it has been my custom to make a horseshoe (transverse) incision, curving up on one or the other side, according to the condition of the gland. It is important to make the incision so as to uncover the upper edge of the gland freely, and then, in going down through the different layers, to separate them slowly and deliberately, with blunt hæmostatic technique, and in this way it has always seemed to me the tumor gradually rose up to meet the operator. Instead of being pressed down into the anterior mediastinum or deeper tissues of the neck, it gradually becomes more and more superficial. If a free superficial incision is made, the technique of the operation is greatly facilitated.

I had some experience in the absorption of thyroid juice in one case of exophthalmic goitre of extreme type, in which the symptoms were very marked, and it seems to me in that case the cause lay in leaving exposed in the wound a considerable surface of stump of the remaining gland tissues which had not been cauterized or excised after the ligature was applied to it. I have had one case of death from tachycardia following exophthalmic goitre. I have not seen any bad effects produced from the absorption of thyroid juice extract in ordinary cases of goitre.

Dr. S. H. Weeks, of Portland, Maine.

I have operated a few times for the removal of goitre, and have been struck with the improved technique of the operation, remembering the method of operating by my predecessor, Dr. Greene, who was one of the early founders of this Association, so that to-day by the improved technique the operation is comparatively safe and simple. But there are many cases in which medical treatment is the only plan we can adopt, and I wish to mention what was stated in an interesting address before the Maine Medical Association a few weeks ago by Dr. Shattuck, of Boston. He claimed that neutral bromide of quinine has been found to be a valuable remedy in controlling the symptoms of Graves' disease.

Dr. Mayo. The point was made in the discussion with reference to absorption from rough handling of goitre. I think the rough handling of goitre comes from insufficient exposure, and that with the handling of goitre for safety we must expose the outside capsule, and expose the whole tumor first before there is any handling of the tumor itself. If this is done it will be perfectly plain work upon the tumor, and there will be no necessity for the rough handling which has been referred to.

With reference to hemorrhage, in any case in which there is a capsule, if you have control outside of the capsule, after shelling out the tumor all it needs to stop the hemorrhage is to make traction upon the capsule. To those who do not drain I would say that they take more pains in closing with the capsule the stump where the amputation of half of the goitre is made, or they use some method like the cautery, carbolic acid, formalin, or some such plan for blocking the absorptive powers of the lymphatics in either the whole region of the wound or over the area where the half of the tumor is severed.

SPLENOMEGALY, ACCESSORY SPLEENS AND SPLENECTOMY.

By AUGUST FREDERICK JONAS, M.D.,
OMAHA, NEB.

In bringing this subject to the attention of the Fellows of this Association no attempt will be made to review the literature on the subject of splenomegaly, for that has been so thoroughly done by Harris and Herzog, in the *Annals of Surgery*, vol. xxxiv.; David Bovaird, in the *American Journal of the Medical Sciences*, October, 1900; Bertram W. Sippy, in the *American Journal of the Medical Sciences*, October, 1899; Jauwein, in Virchow's *Archiv f. Path. Anat.*, 1900, vol. xvi. p. 461; Warren, in the *Annals of Surgery*, vol. xxxiii. p. 513, and others, that nothing can be added here except to record a case, as indicated by the title, that came under our observation. While only one case will be mentioned here, it was our privilege to have another case of splenomegaly some years previous to the one that will occupy your time for a few moments to-day. Unfortunately, however, all data relating to that case have been lost, and as the mere recital of a few bare facts relating to the splenectomy and the subsequent death, about five months later, can be of little scientific value, no effort will be made to burden the records of the Association with it.

I beg leave to record this case for the reason that the cases of primary splenomegaly thus far recorded are not numerous. M. L. Harris, in his excellent résumé of the subject in the *Annals of Surgery*, vol. xxxiv., cites seventeen cases collected and reported by Sippy, and adds two of his own. I also desire to record that

accessory spleens were found in the case I am about to report. The notes as collected in our case are as follows:

S. W. P., aged thirty-nine years, an American, farmer, was admitted to the Methodist Episcopal Hospital April 15, 1902. He had the appearance of a laborer. He was of rather spare build, weighing about 135 pounds. Active out-door life had given him a decidedly ruddy complexion. He walked with moderate firmness, assuming a slight stooping posture, somewhat favoring the left side and extremity and leaning toward the right. He sat down in a chair with some deliberation, extending the left lower extremity and pushing the left side of the body forward. His respiration was somewhat embarrassed. He exhibited no signs of pain or distress. He stated that in childhood and early manhood he had had successively measles, whooping-cough, mumps, smallpox, ague, and pneumonia. His father and mother were still living and were free from infirmities. He had two brothers and one sister living, and all were in the best of health. He further stated that during the past fifteen years, and up to his present indisposition, he had enjoyed the best of health.

In November, 1901, he observed for the first time an enlargement in the left side, about midway between the costal arch and the iliac crest. The enlargement increased until it seemed to fill the entire left half of the abdominal cavity. As the left side became enlarged he found that his discomfort was less when he leaned toward the right side. Later it became impossible for him to stand erect, because "some swelling" in the abdominal cavity prevented him from so doing. He stated that his appetite had always been good, his digestion unimpaired, and bowels always regular. He found that recently respiration had become difficult, partly when he exerted himself and partly on account of pressure from below.

Examination. On exposing the abdominal surface the skin was noted to be rather pale, and on the left side a number of greatly enlarged subcutaneous veins presented themselves. The left half of the abdomen was very much enlarged. The distance between the costal arch and left iliac crest was four inches greater

than the distance between these points on the right side. On palpation it was found that this swelling was due to a solid mass reaching from the left iliac fossa upward to the diaphragm, crowding the latter upward to the fifth rib and displacing the heart almost to the middle line of the sternum. The mass in the abdominal cavity extended beyond the median line for nearly two inches. The examining hand could be crowded beneath its free border, and in moving the hand upward and downward a distinct notch could be felt in the middle part of the well-marked margin. The mass was slightly movable from side to side, but the movements were apparently limited on account of its size rather than by adhesions or a broad attachment. Pressure or manipulation caused no tenderness or pain.

The heart's apex beat was displaced one and one-half inches to the right of the mammary line, and a part of the fundus, as shown by percussion, was beneath the sternum. Friction sounds were heard with both systole and diastole, evidently due to the upward pressure of the diaphragm causing a rubbing of the heart against the pericardium. The lungs were normal, except for the reduced size of the left one, due to the high position of the upper border of the abdominal tumor, causing a diminution in the size of the thoracic cavity. Liver dulness extended from the sixth rib to nearly two inches below the costal margin, due to circulatory stagnation dependent on the labored heart. The kidneys were normal, urinalysis negative (specific gravity 1018). The lymphatics were unaffected, no lumps, nodes, or swellings being found anywhere. No evidence of old ulcers or other injuries was present. No bone or joint disease was to be seen.

A brownish-yellow or bronzed condition of the skin over the upper and anterior part of the chest, back, abdomen, and inner part of the thighs was noted. No other pigmentation was present.

The pulse while sitting was 110; in the recumbent posture, 90; temperature, 98.5°; respiration, 32, sitting or lying down.

A blood examination revealed: hæmoglobin, 60 per cent.; erythrocytes, 4,500,000; leukocytes, 25,000. No differential leukocyte count was made at this time.

In summing up the clinical data in this case, there seemed to be no evidence that we had to deal with any form of leukæmia and no systemic hæmatogenous affection. The case was regarded as primary splenic hypertrophy. The patient desired an operation to relieve the uncomfortable fulness in his abdomen, and, since splenectomy seemed indicated, it was done on the following day, April 16th, the spleen being removed through an incision in the left linea semilunaris.

The organ was dislodged with some difficulty on account of its great size. The upper end crowded the diaphragm upward to the fifth intercostal space, and its lower end extended into the pelvis. After several repeated efforts the lower end was brought out through the long wound, and the remaining portion followed readily. The pedicle was very easily identified, and on its splenic end were found five small bodies varying from one inch to four and one-half inches in diameter, and being one inch in thickness. Each body was attached by a short pedicle, and each pedicle contained a special artery and vein communicating with the splenic vessels. The structure of these bodies resembled that of splenic tissue. They were regarded as accessory spleens, and this opinion was later verified by microscopic examination. It was decided to allow one of the accessory spleens to remain. The pedicle was transfixed with formalin catgut, and the hypertrophied organ was removed, together with four of the smaller spleens, allowing the fifth to remain attached to its pedicle. The abdomen was then closed, and the patient made an uninterrupted recovery, remaining well until the present time.

Blood examinations were made during the convalescence of the patient on April 19 and 29, and on May 8, 1902, as follows:

	April 19th.	*April 29th.*	*May 8th.*
Hæmoglobin	70 per ct.	55 per ct.	70 per ct.
Red cells	6,030,000	5,300,000	4,250,000
Leukocytes	49,400	36,000	43,000
Small lymphocytes	73.75 per ct.	65 per ct.	72.5 per ct.
Large lymphocytes	4.50 "	11 "	6 "
Polynuclear	21 "	22.5 "	20 "
Eosinophiles	0.75 "	1.5 "	1.5 "

The spleen immediately after removal weighed seven and three-fourths pounds. The accessory spleens were removed for further examination. The present weight of the large spleen, after having been preserved for upward of two years in 4 per cent. formalin solution, is three pounds and eight ounces. The dimensions at the time of removal were as follows: Length of convex surface, $18\frac{3}{4}$ inches; width, $12\frac{3}{4}$ inches; length of hilum surface, 15 inches; width, $12\frac{3}{4}$ inches. Greatest thickness, $8\frac{1}{2}$ inches.

A microscopic examination of the tissues of the fresh specimen presented the following:

"First section through the discolored area on the convex surface. One end of section shows practically normal spleen tissue and capsule normal. The other end shows characteristic organizing blood clot. The intermediate space (narrow) shows extravasated blood with a few leukocytes.

"Second section from normal looking spleen. Shows practically normal spleen structure with hyperplasia of endothelial cells.

"Third section from supernumerary structure. The appearances are identical with those of the second section.

"Fourth section through discolored border in the region of the splenic notch. Findings are like those of the first section, except that we have a denser fibrous development, showing a more advanced stage of organization. The coalescence of normal with pathologic tissue is more irregular.

"Sections from the accessory spleens exhibited normal spleen tissue." (Yeakel.)

"The formalin specimen presents lobulations at its hilum. The two largest measure, respectively, two and three inches long and apparently merge into the spleen at the point of entry of the vessels into the organ.

"The convex surface of the spleen shows a number of infarctions, varying in size from a pea to that of a walnut. All of them are of a white color, and some project slightly above the capsular surface. Near the centre of the convex surface is a scar running in the direction of the long axis of the organ about two inches from

the free margin and appearing as an irregular line two inches long and half an inch wide, resulting from the coalescence and secondary pathologic changes of several adjacent infarctions and their ultimate contraction.

"On palpation one receives the impression of one or more cavities in the interior of the organ. Both surfaces of the organ are smooth, the color varying from a light to a dark brown.

"Upon removing a wedge-shaped section from the convex surface of the organ, the interior is found honeycombed with cavities of various sizes, partly filled with cellular debris and other remnants. Across these cavities are stretched irregularly sized bands and thick trabeculæ of softened grayish connective tissue, there being but about one inch of solid tissue forming the outer boundaries of the great cavities with their branches. This condition of the interior of the organ is due to liquefaction on account of the imperfect hardening of the specimen, an opinion which is proven by the great shrinkage in weight of the organ since its removal.

"Microscopic sections from the larger lobules near the centre of the hilum show the capsule to be greatly thickened from an increase of new fibrous connective tissue. The trabeculæ pass inward, are continuous with this structure, and are also very much increased in thickness, appearing in cross-section as wedge-shaped masses or thick bands.

"The few muscular fibres which are present are greatly hypertrophied, their nuclei staining prominently and being in the form of rods.

"The spleen pulp shows an immense increase in the number of lymphoid cellular elements, encroaching upon and in many instances filling up more or less completely the follicular spaces of the organ. The walls of these spaces are also thickened somewhat beyond normal.

"In places the splenic pulp does not stain well. It takes on a reddish color, the nuclei and protoplasm of the lymphoid structures being cloudy and swollen (hyaline change). In some of these areas there are collections of golden-brown pigment.

"The adenoid sheaths of the arteries (Malpighian corpuscles) are lighter in color than normal, and show distinctly some fibrous connective tissue. In a few instances, near their margins, a slight amount of pigment is deposited.

"The vessels, both large and small, show an extensive thickening of their walls, especially in the adventitia. In fact, the smallest vessels—the terminals—are so greatly thickened that they resemble in structure small arteries.

"The debris from the interior of the organ consists of lymphoid cells in different stages of degenerative destruction, shreds of fibrous connective tissue more or less destroyed apparently by putrefactive and fatty changes, free pigment, and amorphous material.

"Sections from the centres of the infarctions in the walls on the convex surface give the typical structures of an anæmic infarct—a condition that is commonly found in chronic hyperplasia of the spleen." (Lavender.)

In reviewing all the above facts it appears that we are justified in assuming that we are not dealing with a leukæmia. The leukocytosis which was present would naturally follow a splenectomy; The hypertrophy was apparently due to a destruction of red blood cells, which made up the large infarcts, as is shown by James E. Ewing in *Clinical Pathology of the Blood.*

RESECTION OF UPPER JAWS FOR OSTEOCHONDROMYXOSARCOMA, WITH OSTEOPLASTIC FORMATION OF NEW HARD PALATE.

By S. J. MIXTER, M.D.,
BOSTON, MASS.

H. W. B., aged thirty years, was referred to me at the Massachusetts General Hospital by Dr. S. W. Allen, who had previously published a description of the case, with photographs, in the *Boston Medical and Surgical Journal*, vol. cxlvii. p. 542. About twenty-two years ago the patient first noticed a slight swelling under the left eye. In two years there was a marked pushing out of the eye and antrum, with difficulty of nasal respiration. When about fourteen years of age the tumor had greatly enlarged, and from this time he had many severe hemorrhages from the nose. Twelve years ago a mass of the tumor sloughed out, leaving a large hole, apparently in the antrum. Sight of left eye was lost at about this time. The patient is small, poorly developed and nourished, but unusually bright mentally. He has been kept in a room by himself for years on account of his repulsive appearance and the odor of the secretions from the mouth, antrum, and ulcerated surface of the tumor. The size and appearance of the mass can be better seen from the photographs than described. There has been little or no increase in the size of the tumor for two years.

The tumor was removed on July 11, 1903. A tube was first introduced into the trachea and the left common carotid was secured by clamp. One incision was made around the ulcerated area, and a second connected the mouth and opening into the antrum. The expanded wall of the antrum was turned back, and with chisel and heavy cutting and lion forceps the mass was

cut, broken, and torn away. There was some hemorrhage, controlled mainly by gauze packing. There was great shock, and though the patient was apparently dead after the removal of the mass, artificial respiration, salt infusion, and stimulation finally revived him. Time of operation, between five and ten minutes. The mass removed included both upper jaws and the new-growth, nothing being left between the tongue and the base of the skull but the soft palate, the right side of the nose, and the eyes. Some of the growth was left in the ethmoidal and sphenoidal regions at the base of the skull. The whole cavity was packed with gauze.

Recovery was slow but uninterrupted, and at the end of twenty-six days the sloughs had all come away and the cavity was clean, presenting the appearance shown in the photograph. An attempt was then made to shut off the cavity of the mouth from the space above, as at this time the patient had difficulty in swallowing food, and could not talk so as to be understood.

In the flap shown in the photograph as held by forceps was a thin shell of bone, probably the expanded wall of the antrum. The edges of this flap were refreshed and trimmed to fit the anterior border of the soft palate, and the sides of the mouth cavity which were denuded and the flap turned in, skin side up, were stitched in place, making a firm roof to the mouth and leaving only a small hole at the left nostril. In a week union was perfect, and the opening in the face was closed without difficulty. Now—a year after the operation—the patient has gained twenty to thirty pounds, can talk perfectly, and can eat soft food. Instead of being shut up in a room, a horror to himself and everyone else, he is able to earn his living. The left side of the face is sunken, but a small patch covers the worst of the deformity. There is only the perception of light in the left eye; the right is normal. In the cavity above the new roof of the mouth no new-growth can be seen. The growth, microscopically, was osteochondromyxosarcoma.

This case is reported not only on account of the extent of the growth removed, but also to show the possibility of the formation of a new hard palate in certain rare instances.

FIG. 1.

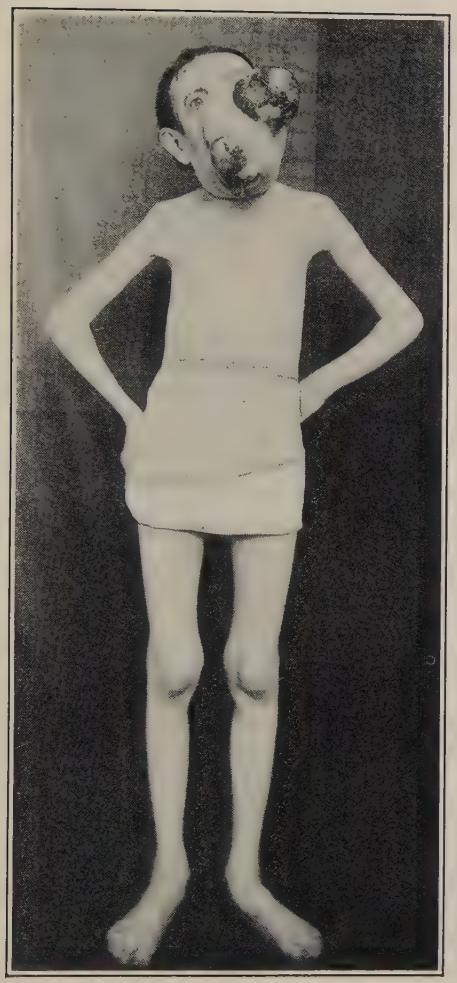


FIG. 2.

Fig. 3.

Fig. 4.

Fig. 5.

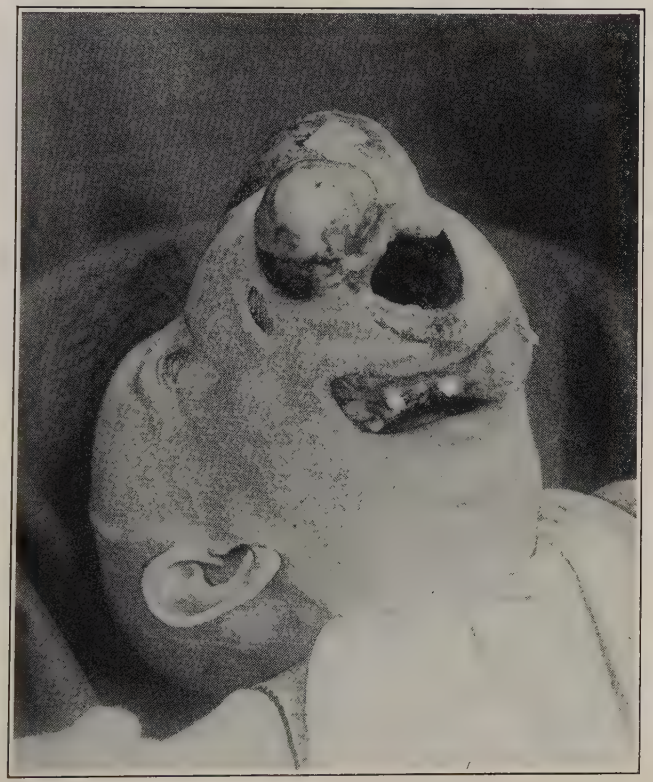


Fig. 6.

Two weeks after first operation.

Fig. 7

One year after operation.

Fig. 8.

Fig. 9.

DISCUSSION.

Dr. Maurice H. Richardson, of Boston.

I saw this boy, in consultation with Dr. Mixter, and pronounced the case absolutely inoperable and hopeless. The patient is now quite presentable, and able to earn a living.

This is one of the most extraordinary cases that I have ever seen, and I wish to pay tribute to Dr. Mixter's great judgment and skill.

Dr. W. W. Keen, of Philadelphia.

I desire to call attention to one feature in connection with sarcoma of the upper jaw, which I think has not received as much attention from surgeons as it should, namely, the extension of the sarcoma through the infundibulum into the frontal sinus. I am sure that in a number of my cases that have lived for years afterward the non-recurrence has been due largely to the removal of this tongue of tissue. In almost every one of my cases of sarcoma of the upper jaw a tongue of sarcomatous tissue has pushed upward through the infundibulum into the frontal sinus. Unless it is looked for, it is almost sure to escape detection and to be the source of early recurrence. Its removal is readily accomplished when the ordinary Ferguson incision has been made by carrying an incision upward just to the nasal side of the inner canthus of the eye over the frontal sinus. By means of a small rongeur forceps the anterior wall of the infundibulum and of the frontal sinus can be removed, and by a small gauze sponge one can wipe away this tongue of tissue. Unless this is done early recurrence is inevitable.

Dr. W. Joseph Hearn, of Philadelphia.

Dr. Mixter must have had considerable courage to do the operation he has described. I do not rise for the purpose of discussing the paper, but simply to call attention to the fact that I always ligate the external carotid in removing sarcoma of the upper jaw. I am not only impressed with the necessity of doing it for arresting any slight hemorrhage which may follow, but I always find large lymphatic glands infected from abrasions in the mouth, sometimes from the sarcoma. Every time I have ligated the external carotid I have found enlarged glands. These enlarged glands exist in almost every case, and are easily removed when preceded by ligation of the external carotid. I am sure if this is done more frequently, although a great many surgeons do not believe it is necessary to ligate the external carotid, it will have a better after-effect, as it cuts off the blood supply.

Dr. Alexander Hugh Ferguson, of Chicago.

I wish to compliment Dr. Mixter on the excellent result he has obtained in so formidable a case. I should like to present the method of extirpation of the superior maxilla through the mouth in all cases where the skin of the cheek is not involved. It avoids the extensive external scars following the late Sir William Ferguson's operation. Preliminary to the operation tie the external carotid artery and spend several minutes in forcibly dilating the mouth. Allow the anæsthetized patient's head to overhang a sand-bag on the operating-table, then make two small incisions on the face about a half-inch long, the first over the nasal process of the superior maxilla and the other at the junction of the superior maxilla with the malar bone. Pass an osteotome along the side of the knife, turn it across the bone and drive it through with a few blows of the hammer, completely severing these two bony attachments of the upper jaw. For capillary hæmostasis pack these two small wounds with iodoform gauze. Cut through the alveolar process and hard palate in the same manner. Save as much of the soft palate as possible. Pass a small, slender knife through the mouth and separate all the soft structures of the cheek from the superior maxilla. With periosteal elevator or forceps, or even with the finger and thumb, evulse the jaw from its cavity, pack with iodoform gauze, and the operation is completed. I presented this operation to the Western Surgical and Gynecological Association four years ago at Minneapolis, but it was not very favorably received. Since then I have performed the operation in every instance for the removal of the superior maxilla, and I am prepared to say from my own experience that there is no disease, benign or malignant, of this bone indicating it where we want to save the skin that cannot be removed through the mouth speedily and efficiently with a minimum deformity of the face.

Dr. Rudolph Matas, of New Orleans, La.

I desire to emphasize the fact mentioned by Dr. Hearn with reference to the ligation of the external carotid artery, which I regard as a valuable procedure if only from a technical point of view. It has been my fortune to have ligated the external carotid sixty-eight times as a prophylactic hæmostatic preliminary to exclusion of the jaws and for the removal of tumors involving the face and head, and especially the tongue and mouth, and I have been pleased with the results obtained by this procedure. There is one point in connection with this preliminary ligation of the external carotid artery worth remembering, and it is this: Always ligate the artery high up, well above the bifurcation. We have always been taught to regard the ligation of the external

carotid as a comparatively benign procedure, because it is presumably free from the risk of cerebral complications. But experience has taught me that there is danger of secondary cerebral complications from embolism if the ligature is applied too close to the bifurcation.

Of the sixty-eight ligations of the external carotid I have had two deaths from undoubted embolism. In a case of resection of the inferior maxilla for malignant disease, in which I extirpated the external carotid, following the plan of Dawbarn (without the paraffin injection) the external carotid was ligated close to the bifurcation, and the patient died on the third day from hemiplegia and progressive cerebral thrombosis. In another case in which I performed Mixter's operation for neuralgia, resecting the superior and inferior maxillary nerves at the base of the skull, I also ligated the external carotid artery, and death followed twenty-four hours later from embolism and hemiplegia. In this case there was extension of the clot from the point of ligation along the bifurcation up into the internal carotid, giving rise to the same complication that would occur in ligation of the internal carotid. Since then I have made it a practice to ligate the carotid some distance away; if possible, between the superior thyroid and lingual branches, including these branches in separate ligatures. I think it is well, therefore, to emphasize the point not to ligate too close to the bifurcation.

GALLSTONES IN THE COMMON BILE-DUCT.

By STEPHEN H. WEEKS, M.D.,
PORTLAND, ME.

It has been shown quite conclusively that three-fourths of the cases of gallstones occur in women, and that 90 per cent. of women with gallstones have borne children.

Courvoisier and Fenger have given much painstaking consideration to gallstones in their practical aspect. According to their investigations, one stone is found at the duodenal end of the common duct in 67 per cent., at the hepatic end in 15 per cent., and at the middle of the duct in 18 per cent. of the cases. One stone is present in two-thirds of the cases; in one-third, two, and even as many as six may be found. In the instance of a single stone the size varies from one-fifth to four-fifths of an inch in diameter.

In 99 cases of cholelithiasis stone was present in the gall-bladder alone in 84 per cent., in the gall-bladder and common duct in 10 per cent., and in the common duct alone in 5 per cent. of the cases.

According to Courvoisier, gallstones are found in the common bile-duct in about 4 per cent. of all cases of cholelithiasis. In 67 per cent. of cases the stone is found in the duodenal end of the common duct, according to Mayo Robson.

When a gallstone is found in the common duct the question at once arises, Did it form there or did it find its way there from the gall-bladder? It is quite evident that calculi may form in the hepatic or common duct.

Diagnosis. Is there any way by which the surgeon can diagnose the presence of a stone in the common bile-duct before the abdominal cavity is opened and the gall-bladder and bile-ducts are explored?

A gallstone permanently impacted in the common duct causes mechanical obstruction to the passage of bile, with jaundice, which continues as long as the impaction does, unless there is a dilatation of the duct, allowing the stone to move forward and backward like a ball valve, in which case there will be intermittent or remittent pain and jaundice.

Impaction in the common duct rarely causes marked dilatation of the gall-bladder; it causes dilatation of the branches of the hepatic duct, and may result in pronounced and even fatal jaundice. The jaundice is intermittent or remittent where the calculus floats in an enlargement of the common duct, because the system will eliminate the bile in the interval.

Obstruction of the common duct is always accompanied by jaundice, but the cystic duct may be occluded and give rise to grave symptoms without there being any trace of jaundice or any history of biliary colic. Jaundice with distended gall-bladder not due to gallstones is presumptive evidence of malignant disease. Jaundice without distended gall-bladder favors the diagnosis of cholelithiasis.

Courvoisier found that in 35 operations performed for obstruction in the common duct, in 18 the obstruction was due to causes unconnected with gallstones—*e. g.*, cancer, tumor, stricture—and in all these 18 cases the gall-bladder was dilated. If there is no enlargement of the gall-bladder with frequent attacks of pain, each attack accompanied by an increase in the jaundice, which is never wholly absent; if there are loss of weight and feverishness during these attacks, and pain in the epigastric region, then we may conclude we have a stone in the common duct.

Prognosis. Maurice Jordon has collected from the literature 72 cases of removal of calculi from the common duct, with 22 deaths. The report does not state the method adopted for their removal or the subsequent treatment.

The great mortality following this operation plainly shows the need of further investigations along this line of work, and it is with this object in view that I have prepared this paper, which includes the report of a case recently operated on by me. It has long seemed

to me that incision of the duct or the gall-bladder, followed by immediate suture, is the ideal operation in the majority of cases, especially in recent cases.

Report of My Own Case.

Mrs. J. R., aged thirty-four years, has had five children. In March, 1903, was seized with a severe pain in the right side, radiating backward through the right side of the back downward toward the right inguinal region, accompanied by nausea and severe vomiting. The attack lasted about two hours, and was followed by jaundice and high-colored urine. For about six months these attacks recurred every two or three days, each one lasting several hours, accompanied with vomiting and followed by jaundice and high-colored urine. For six weeks prior to the operation she had an attack every day, and the jaundice was almost constant. She had lost much in strength and flesh.

Operation, October 24, 1903. The usual incision was made, and when the liver was exposed it was found considerably congested and of a darker hue than normal. The gall-bladder was not enlarged, and when opened no gallstones were found. At this stage of the operation I confess that I was much disappointed, and for a moment thought I had made a mistake in my diagnosis. Recalling the history of the case, I felt that I could not be mistaken; there must be some obstruction to the biliary passages. I turned the stomach and transverse colon downward and to the left, and, exposing the common bile-duct, I found a stone lodged in the duct near its middle portion. The duct was dilated, and the stone could be moved forward and backward, but could not be passed onward into the duodenum. The stone would float as if it were in the dilated portion of the duct.

The duct enclosing the stone was grasped between my thumb and finger and incised directly over the stone, in a line parallel with the course of the duct, and the stone removed without relaxing my grasp of it. There was very little bile in the gall-bladder, and only a small flow from the incision in the duct. The openings into the gall-bladder and common duct were closed by immediate catgut

suture, two rows of sutures being used, the last row being Lembert's sutures. A strip of sterile gauze was introduced into the space beneath the liver, coming out at the upper angle of the incision. The abdominal wound was closed, excepting at the point of the gauze drain, where there was a provisional suture to be tied when the gauze drain was removed. At the end of forty-eight hours, there being no signs of leakage at the openings into the gall-bladder and common duct, the gauze drain was removed and the provisional suture tied, closing completely the external incision. My patient made a rapid and uninterrupted recovery. I most thoroughly believe that immediate suture of the incisions into the biliary passage is the ideal operation where this is practicable.

The operations which have been made for the removal of stones from the common bile-duct are choledochotomy, cutting into it and removing the stone through the incision, as described above; cholelithotrity, in which the stone is crushed through the walls of the duct by means of specially padded forceps, and then by manipulation forcing the fragments into the duodenum.

It seems to me that cholelithotrity is risky, from the possibility of serious damage to the duct wall. The objection to choledochotomy, so frequently made, is the danger of leaving a fistula. Some surgeons have succeeded in piercing the stone with a needle, thus breaking it up and forcing the fragments into the duodenum. These piercing and crushing operations are much more likely to do serious damage to the duct than a clean incision made with the knife, which can be immediately closed by suture. In cases where the stone is lodged near the duodenal opening of the duct, Dr. McBurney has successfully removed it by incising the duodenum, slitting up the duct, and thus reaching the stone.

The late Christian Fenger, of Chicago, in reporting 3 successful cases, called attention to the danger of pushing the stones floating in the common duct into the hepatic duct and out of reach while manipulating.

A case of dilatation of the common bile-duct simulating distention of the gall-bladder is described by F. H. Edgeworth, of

Bristol. If it is found impossible to suture the opening in the common duct, a drainage-tube may be carried down to the opening, not into it, and the tube packed around with sterile gauze. The opening will close by granulation.

Summary. Impaction of a gallstone in the common duct rarely causes marked distention of the gall-bladder; it causes dilatation of the branches of the hepatic duct, and may result in pronounced and even fatal jaundice.

Obstruction of the common duct is always accompanied by jaundice, the jaundice is intermittent or remittent where the calculus floats in an enlargment of the common duct, because the system will eliminate the coloring matter of the bile in the interval.

The cystic duct may be occluded and give rise to grave symptoms without there being any trace of jaundice or any history of biliary colic.

Jaundice with distended gall-bladder not due to gallstones is presumptive evidence of malignant disease.

Jaundice without distended gall-bladder favors the diagnosis of cholelithiasis.

Treatment. The treatment is necessarily surgical. The operations usually made use of for the removal of gallstones from the common bile-duct are choledochotomy and cholelithotrity. Incision into the common bile-duct is a most important and interesting proceeding. The duct lies upon the portal vein, and the cystic artery lies alongside of it. If one keeps in mind the anatomy of this region, it is evident that, by the same incision as for gall-bladder operations, the deeper part can be exposed. It is well to raise the shoulders and lower the hips of the patient to cause the colon and small intestines to fall away from the field of operation. The distention of the duct by a stone gives little risk of cutting back of it, if care is used in making the incision. An incision in the length of the duct will allow the stone to be easily removed. The duct wall is much hypertrophied where it has enveloped the stone, and has a pink appearance, as if the muscular coat had been developed in its effort to push onward the calculus. The stone being removed, it is an easy matter to suture the duct with a con-

tinuous catgut suture. A second layer should be taken to strengthen and bury the first, the two serous layers being brought in contact after the Lembert method. If the parts are too much inflamed or the condition of the patient does not justify a prolonged operation, it is perfectly good surgery to press the walls of the incised duct together by a gauze strip folded and packed down upon it, its end being brought to the surface, and to place alongside of it a rubber drainage-tube. In a few hours all adjacent viscera will be sealed about it by lymph, excluding the bile from the peritoneal cavity. In two or three days the tube and gauze may be removed and the tube replaced alone for ten days. It is my custom to put in a wick of sterile gauze, even in those cases where there has been immediate suture, which shall act as a drain in case of any leakage around the sutures. This gauze drain should be removed in forty-eight hours, and if there is no escape of bile the provisional suture, put in at the time of operation, is tied and the external wound completely closed.

The other operation, cholelithotrity, I have never made, believing that the needle used to prick the stone to bits through the wall, after Tait's plan, or padded forceps used for crushing the calculus in the duct is much more likely to injure the duct than a clean incision made with a sharp knife. As I have before said, I believe the incision of the duct with immediate suture is the ideal operation.

DISCUSSION.

Dr. Maurice H. Richardson, of Boston.

This subject is a very broad one and suggests many matters of interest. The trouble is that the subject of gallstones is so vast and the complications connected with the biliary tract are so varied that in a brief discussion very little can be said about the matter. We are, however, learning new and important facts from every paper and every case that is presented. In my very first case—or in one of my earliest cases—I drained by putting a tube into the hepatic duct. I remember that Dr. Keen was present during this operation. This method I published in 1892.

Subsequently I changed from this method of treating the ducts to that of suturing when possible. Owing to the failure of the suturing and to other causes, drainage, though unintentional, became spontaneously established. I had already been impressed by the good results in drainage of the gall-bladder, and, through this unintentional drainage of the common and hepatic ducts, I found not only that the wounds healed spontaneously after a few weeks' drainage—like the healing after perineal section in urethral surgery—but that the effect of the drainage itself was of the most beneficent character. The conviction was unavoidable that the essential thing in gall-bladder surgery, and especially in those cases in which a gallstone is impacted and the gall-bladder contracted, is drainage. Suture of the normal or comparatively normal gall-bladder, in my experience, proved dangerous, and was soon abandoned.

With a contracted gall-bladder and a dilated cystic duct, I have usually removed the gall-bladder and put a drainage-tube into the dilated duct. The results after this method of treatment have been brilliant. In many cases I have put the tube through the cystic duct into the hepatic and have fastened it there. It is not always necessary to drain through the cystic duct after a satisfactory extirpation of the gall-bladder. I have never done this when there has been no jaundice and when the cystic duct has not been dilated. Indeed, it is no easy matter to drain through an undilated cystic duct. I do not say that it is impossible, but I do say that it is impracticable. It seems to me a difficult operation to drain a normal, undilated hepatic duct. When, therefore, the operation consists simply of the removal of a diseased gall-bladder—without infection of the hepatic, the cystic, or the common duct, and with no dilatation of these ducts—the advantages of drainage have been somewhat overbalanced by the difficulties and dangers of the

dissection. It is in cases of this kind that I have had the best results from cholecystectomy.

The complications have arisen in cases of contracted gall-bladder and cystic-duct drainage. These are, I dare say, unavoidable by any method of treatment. After we have once drained the biliary passages there is very little chance of our having to drain them a second time; but if the gall-bladder remains, re-drainage will be very easy. Re-opening of the hepatic or cystic duct may be, and generally is, extremely difficult and dangerous. The space occupied by the gall-bladder is, after the operation, filled in with contiguous structures—the stomach, the duodenum, the hepatic flexure of the colon, the omentum, the kidney—sucked against the surface of the liver left raw by the dissections of the cholecystectomy. Nothing may be easier, perhaps, for the skilled dissector than the demonstration of the common or the hepatic duct in the normal subject. After a large experience in the dissecting-room and at the operating-table, however, I cannot but regard the mechanical difficulties of isolating and draining the hepatic duct—even as a primary operation, but especially as a secondary operation—as one of the most difficult and dangerous operations in surgery. If this operation is not difficult, and if it is not dangerous, then no operation which requires cutting in the immediate vicinity of enormous arteries and veins can be. The deep neck is child's play, compared with it, for there the surgeon has an accessible and well-lighted field. From the point of view of my own experience, however, the results of this dissection may be regarded as not dangerous, for I have never cut the inferior cava or the portal vein, or torn a hole in the duodenum, or cut off the blood supply of the colon, or wounded the great vessels of the liver. But that I have not is to be attributed to the fact that I regard this as a difficult and dangerous region—a region in which extreme care and deliberate dissecting are imperative.

Dr. Weeks, in his paper, dealt very largely with the diagnosis of gallstones in the common duct and the diagnosis between impacted stone and cancer of the pancreas. He referred to Courvoisier's law. As a general rule—which I think will be indorsed by surgeons of the largest experience in diseases of the biliary passages, and which may be demonstrated on the operating-table—dilatation of the gall-bladder with jaundice means obstruction in the pancreas; contraction of the gall-bladder, with or without jaundice, means gallstones. When the obstruction begins in the common duct and pancreas the gall-bladder is unchanged and becomes easily dilated. If a gallstone could be formed in the common duct without any pathological change either in the hepatic or in the cystic duct or in the gall-bladder, there would always be dilatation.

The method of crushing gallstones hidden in the depths of the gall-bladder or in the ducts is occasionally useful, but to me it seems a dangerous procedure. I once crushed with the fingers a gallstone in the common duct during an abdominal operation. The gallstone was very easily broken up and gotten rid of. This patient died, however, from the original operation,

In another case, that of an old man, I found a gallstone impacted in the common duct, and was able, with the greatest ease, to crush it between my thumb and finger and to get rid of it. This patient made an excellent recovery. The method is, however, clumsy and dangerous, and ought to be avoided in every case in which the anatomical precision of the knife can be substituted for it.

Dr. Leonard Freeman, of Denver, Col.

I wish to emphasize the fact that gallstones can exist in the common duct without jaundice. I shall mention briefly two cases that I have recently operated upon. In one there were thirty-seven gallstones found in the common duct; in the other a large mass of putty-like material accompanied by several smaller gallstones. To be sure, the gallstones existed in an expansion of the common duct, but it was the inference that they passed through the common duct to reach the space which they occupied, unless this were a congenital diverticulum. The two intelligent patients absolutely denied having had jaundice at any time. This is a matter of some importance in relation to prognosis before operation at least.

Dr. Weeks. I am extremely indebted to Dr. Richardson for his criticism of my paper.

I am a thorough advocate of drainage, as all the other members of the Association well know, for when I was made a Fellow of the Association the paper which I presented at the time was on the subject of drainage, under the title of "Drainage and Drainage-tubes in the Treatment of Wounds."

Since preparing the paper which I have read to-day I have operated for the removal of gallstones where I closed the wound by immediate suture, and afterward I wished I had left the wound open for drainage.

I believe immediate suture of the incision into the gall-bladder and common duct should be limited to cases free from inflammation.

In all cases where there is inflammatory action the safer plan is drainage.

A NEW OPERATION FOR INTESTINAL STENOSIS, WITH ESPECIAL REFERENCE TO COLONIC CANCER.

By THEODORE A. McGRAW, M.D.,
DETROIT, MICH.

It has been the experience of all surgeons that resections of the colon are followed by a high rate of mortality. Wolfler, in a paper read before the German Surgical Society in 1896, stated that 54 per cent. of such operations on the large and small intestines resulted in death. Korte, in 19 cases of colonic resection for cancer, had seven deaths, but as 6 of the 19 cases were in the ileocæcal region, and as all of the six recovered, there remained 13 cases involving other portions of the colon, with a mortality of nearly 54 per cent. The fatality rate differs, therefore, with the location of the disease. The greatest success has been attained in the ileocæcal region, and next to that with the sigmoid, while radical procedures on the transverse colon and the colonic flexures have been exceedingly disastrous.

The success attained in the ileocæcal region has probably been due, in large part, to the ability to isolate that part of the gut and to protect the abdominal cavity from infection. It may be, too, that the intestinal contents, which in case of obstruction in that region accumulate in the ileum, are less virulent than those which collect in the colon when the obstruction is farther down. However that may be, a careful study of these operations leaves little doubt that the greatest danger is the exposure of the abdominal cavity to infection from the cut bowel. Beside this, the causes of the high rate of mortality are to be found in the general con-

dition of many of these patients when they are operated upon, the diseased condition of the gut above the seat of obstruction, the changes which take place in the intestinal contents from long retention, and from their mixture with secretions from the congested mucous membrane, and from the attempt to make end-to-end anastomoses in bowels differing enormously in size. Many of these operations, too, have to be made at a time when the partial chronic obstruction has become complete, when the patient has become exhausted by a long, painful struggle, and when the bowels have become acutely congested and inflamed.

The operation becomes, then, urgent, and the surgeon may hardly allow himself time for a thorough examination of the case, and cannot delay action until he has brought the patient into a better condition. Under such circumstances operations are done at a great disadvantage, and many patients die who might have been saved if operated on at an earlier period. If the bowel is resected when the abdomen is open the greatest difficulty is experienced in preventing infection. The whole intestine, except that part below the seat of stenosis, is full of long-retained feces, which have acquired a highly virulent quality. To empty the gut requires a long time, during which the intestines are more or less exposed.

If an end-to-end junction of the cut bowel is attempted, the surgeon is puzzled by the difference in calibre and in quality of the two ends, for the proximal end is dilated often to a diameter of three or five inches, and has walls which are knobby and parchment-like, while the distal end is contracted to half of the normal size, and is soft and pliable.

The German surgeons have sought in various ways to overcome these difficulties. Mikulicz was the first to abandon the "one-time" operation and to resort to a method of operating in which the gut in one operation was fastened outside of the abdominal cavity, in a second resected, and in a third repaired. His method is as follows:

First of all the abdomen is opened and the diseased area freed from its attachment and stripped of its bloodvessels.

The mesenteric glands are removed and the rents in the mesentery repaired.

The two limbs of the affected coil are then brought parallel to each other and fastened together with Lembert stitches. The tumor and three or four inches of the intestines are next brought out of the wound and the abdomen closed snugly around them. The parts to be removed having been deprived of their bloodvessels mortify, and in two or three days are ready for removal and are cut off. A glass tube inserted into the afferent branch carries off the fecal discharge. Two weeks later the spur between the two bowels is divided by a clamp, the adhesions formed between the two rendering the operation without danger to the other viscera. Of twelve cases thus treated ten recovered.

Hochenegg has had success with a similar operation without, however, resorting to that unnecessary measure of depriving the gut of its bloodvessels and thus inducing gangrene. He brings the tumor well out of the abdomen, prevents its retraction by passing a fold of iodoform gauze through the mesentery, and closes the abdominal wound around the bowel with sutures. After a few hours he makes a small opening in the distended afferent limb, inserts a glass tube, and empties the intestine. At the end of ten or twelve days the abdomen is reopened, the tumor and adjacent parts of the gut are excised and the two ends united with circular suture.

The objections to both of these procedures are the multiple operations necessary to their completion.

The deliberate production of gangrene in Mikulicz's procedure seems to me unnecessary and useless, while the cure of a false anus by clamping the spur is tedious and imperfect when it does occur, and often fails to take place even when the spur has been destroyed. In that case the surgeon has to resort again to laparotomy and to resection of the bowel. Hochenegg's procedure necessitates an opening of the abdomen and a junction of the bowel in an exhausted patient who has barely recovered from a laparotomy.

That these secondary operations are by no means devoid of

danger is proven conclusively by Wolfler's statistics, in which a mortality of 22 per cent. is reported in operations for the cure of false anus.

Stimulated last winter by a fatal case of colonic resection for cancer, I have given considerable study to the technique of these operations. It has seemed to me that the existing methods of procedure might be very much improved, and I venture to bring before the profession a method of operation which, I hope, may prove in practice what it seems to me to promise in theory.

The main and essential things in operations for colonic cancer are:

1. The protection of the abdominal cavity from infection by deferring the evacuation of the intestinal contents until the abdominal wound has been completely closed and hermetically sealed. This can be done only by bringing the tumor out of the abdomen and fastening it there while the gut is opened.

2. The avoidance of all serious secondary operations which would bring new risk to the patient. I propose to accomplish these objects in the following manner:

Given a tumor or a stenosis of the colon, every effort should be made to locate exactly the seat of disease, as the knowledge of its location enables the surgeon to make the abdominal incision at the most favorable point. For this reason such cases should be carefully studied beforehand and never operated on without the most careful investigation. If the tumor can be felt its location is plain. In the many cases in which it cannot be felt we may, nevertheless, locate approximately the seat of the stenosis by studying the reactions of the afferent and efferent limbs of the bowel.

That contraction of the intestine, which is the invariable accompaniment of an obstruction, can often in a thin person be seen through the abdominal wall. There is a wave of distention which begins at a distance from and ends at the point of stricture. Careful examination of this wave-like tumor will often show the acute observer in what portion of the abdomen the stenosis is situated. If the stricture does not completely close the gut the passage of

fluids or semifluids and gas through the narrowed portion is announced by a gurgle, which is most distinct over the seat of trouble.

The location, then, of the end of the abdominal wave and of the loudest gurgle will, in many patients, enable us to locate the seat of disease.

We may also locate it by watching the effect of a large high enema in the efferent bowel, for if an enema of water were pumped into the colon in sufficient quantity to dilate it we should find that the distention would occupy only that portion of the bowel below the stricture. Distention with gas would answer the same purpose. In very fat persons the phenomena thus caused are not so perceptible, and in some cases complications of any kind might obscure the diagnosis. Indeed, careful and repeated examinations can alone give that surety in such cases which would warrant the surgeon in directing his operation by his diagnosis.

If the tumor can be even approximately located, the abdomen should be opened directly over it. If that is impossible, the exploratory incision should be made in the median line. The tumor or stricture having been found, the coil in which it is seated should be drawn out of the abdomen, and, if necessary for this purpose, adhesions should be broken or cut, enlarged mesenteric glands should then be removed and the mesentery repaired. At this stage the two limbs of the intestine leading to and from the tumor at a sufficient distance from the seat of disease should be joined together by Lembert sutures and an anastomosis made with an elastic ligature. If the exploratory opening in the abdomen should seem best adapted for the purpose, the wound should now be closed snugly around the protruding coil, the ligatured portion remaining in the abdominal cavity, and the tumor, with a length of gut of two or three inches, outside of the abdomen. If the exploratory incision is made in the median line and the tumor is found to exist at either angle of the colon, it would be better to close the median incision and make a new one over the tumor just large enough to permit of its easy exit. In every case the tumor should be drawn out of the abdomen at that point

which would most nearly permit the resected intestine to occupy its normal position.

When the wound has been closed and sutured to the protruding intestine, a firm silk ligature should be tied around the efferent limb just below the tumor and the gut cut off below it, care being taken that not the least portion of its contents is allowed to come in contact with the wound. This part of the gut is small, contains little feces, and is easily cleansed and disinfected. It may now be closed with a circular suture inverted into itself and pushed in until its outer surface no longer projects beyond the level of the skin. A few Lembert sutures will now hold it in position, and the integument may be brought over it and sutured. In this way the efferent limb is, once and for all, disposed of.

When the gut is divided just below the ligature the afferent distended portion should be seized by an attendant and wrapped in gauze. As soon as the efferent limb has been hidden under the integument, the surgeon should carefully examine the sutured line which fastens the proximal bowel of the integument and see that the abdomen is thoroughly closed. Layers of gauze soaked in collodion should then be placed over the whole wound so as to seal it hermetically. A large trocar such as has been used for the discharge of fluids from ovarian cysts in operations for the removal of those tumors may now be thrust into the intestine and the feces discharged. A rubber tube attached to the trocar will carry them into a proper receptacle.

When the gut has been thoroughly emptied of feces, the diseased portion should be cut off and a large glass tube inserted into the bowel and tied in place by an encircling ligature. To this a rubber tube is attached for the disposal of feces. At the end of four or five days the feces will find their way through the new channel of anastomosis and pass into the lower bowel. As soon as this is determined by fecal discharges per rectum, the tube may be removed, the gut sutured and turned into itself, and the wound in the integument closed over it. In this way we shall have guarded the abdomen from all contamination from the opened bowel and have excised the diseased portion, and

made the anastomosis and completed the work in what is practically but one operation, for the final disposal of the proximal end by inversion and suture can hardly be dignified by the name of operation.

It is evident that the success of this procedure will depend upon the success of the enteroenterostomy with the elastic ligature.

It must be remembered that the great distention of the proximal portion of the colon will tend to force a discharge through the smallest aperture. For this reason the rubber ligature must be passed with the greatest care. I should not trust an ordinary needle for this purpose, because, even though the ligature is put on the stretch, it would offer a shoulder which might unnecessarily enlarge the opening made by the needle.

The McLean needle, which I have used in anastomoses of the bowels, does away with the shoulder made by the doubled rubber thread and permits the use of a ligature much larger than itself. Notwithstanding the slight shoulder caused by its ferrule it is an excellent instrument. The Smith needle is absolutely free from all shoulder and answers the purpose admirably. If the large-sized rubber is used with this needle it can be passed while on the stretch and will immediately expand beyond the size of the aperture, filling it completely.

The thickest portions of the large intestine are those occupied by the longitudinal bands, and these should be chosen for the passage of the needle, as the danger of any extravasation would be diminished thereby to the uttermost.

EXCISION OF THE CLAVICLE.

By N. B. CARSON, M.D.,
ST. LOUIS, MO.

THERE seems to be doubt to whom is to be credited the honor of having first excised the entire clavicle. Treves[1] gives McCreery, of Kentucky (1811), the credit of having first removed this bone in its entirety, while Gross[2] says that Remmer was the first to excise the clavicle in 1732, while Rudolph Zabel[3] says the oldest known total extirpation of the clavicle was done by Moreau and D'Angerville, of Paris, in 1765, and that the operation by Remmer, which by most authors is considered as the oldest, was without doubt not a total, but only a partial extirpation.

O. Heyfelder[4] gives credit to Meyer for total (1823) and to Cassebohm for partial extirpation (1719). A careful consideration of the literature leads me to conclude that Zabel is correct, and that Moreau and D'Angerville were the first to perform total extirpation of the clavicle.

The bone has been removed entirely or in part for caries and necrosis, morbid growths, and displacements, the result of disease. Gross[5] says Mr. Davie many years ago excised the inner extremity of the clavicle in a case of dislocation backward from deformity of the spine, the luxated head causing such a degree of pressure on the œsophagus as to endanger life by inanition.

The *Transactions of the London Pathological Society* record the removal of a few examples of sarcoma of the clavicle post-mortem.

[1] Operative Surgery, vol. i. p. 638.
[2] System of Surgery, vol. ii. p. 1077.
[3] Zur Casuistik der Total Extirpation der Clavicle.
[4] Lehrbuch der Resection, 1863, p. 300.
[5] System of Surgery.

In one instance the growth produced death by pressure on the trachea within seven weeks after its known commencement.

The operation of the excision of the clavicle, in part or entirely, on account of caries or necrosis has been to me a very easy operation, although some writers consider it quite serious. Several times I have removed quite a considerable part of this bone, involving one or the other of the extremities, or shaft, and have not considered the procedure worthy of more than bedside notes, as the operation consists of simply enlarging the already existing opening and lifting the diseased fragments from their bed.

On the contrary, the excision of the clavicle for morbid growths is an operation of the most serious character, both on account of the immediate and the ultimate dangers. Velpeau[1] calls the operation a daring attempt, never carried into effect except in a few cases of operation upon the shoulder. "Yet," he says, "there are circumstances sufficiently numerous which require this operation if we wish not to abandon the sufferers to certain death."

Gross,[2] in speaking of the difficulties presented by the two operations, the one for necrosis and the other for tumors, says: "But the case is widely different where the clavicle is buried in a large mass of disease, when the circumjacent structures are all intimately matted together by morbid deposits, and where not only the great vessels of the neck but likewise the principal nerves and thoracic duct are in close proximity to the affected bone, as in the case of Mott"[3] (requiring over forty ligatures and four hours for its completion). "Under such circumstances the operation must be of extraordinary difficulty, demanding the greatest patience, skill, and anatomical knowledge for its successful execution."

While I can appreciate the difficulties that may be encountered in this operation, I was much surprised at the ease with which it was accomplished in my case, although the tumor was of large size and involved the sternal end. A study of the literature also made me think the dangers more imaginary than real, and that

[1] Rouse, London, March 23, 1889, vol. i. p. 575.
[2] Operative Surgery, 1835, first edition.
[3] Gross, System of Surgery, vol. ii. p. 1040.

the operation with ordinary care and a thorough anatomical knowledge should be one of very small mortality.

Searching the literature I find 49 well-authenticated cases of removal of the clavicle, in part or entirely, for tumors, simple or malignant, with 42 recoveries and 7 deaths, a mortality of 16 per cent. Of these, 40 were for osteosarcoma and 4 for carcinoma; 3 simple or non-malignant, and in 1 the character of the growth was not given.

Delatour[1] has collected 40 cases, with a death rate of 18 per cent., and Barling[2] 24 cases, of which number 6 died within five weeks, but in 2 of them death cannot be attributed to the operation, as 1 died of brain tumor the other from hæmatemesis. Barling thinks this rate (16 per cent.) may be unduly low, as some of the unsuccessful cases probably remain unreported. Of the 18 cases which recovered, he has been able to trace only 12, and some of those but for a short time. Five were either dead or dying of recurrence within twelve months after excision. Four were well at periods varying from three to twelve months after operation, and of the 3 remaining 1 was alive three years and another ten years, while the third one—Mott's case—remained well fifty-four years.

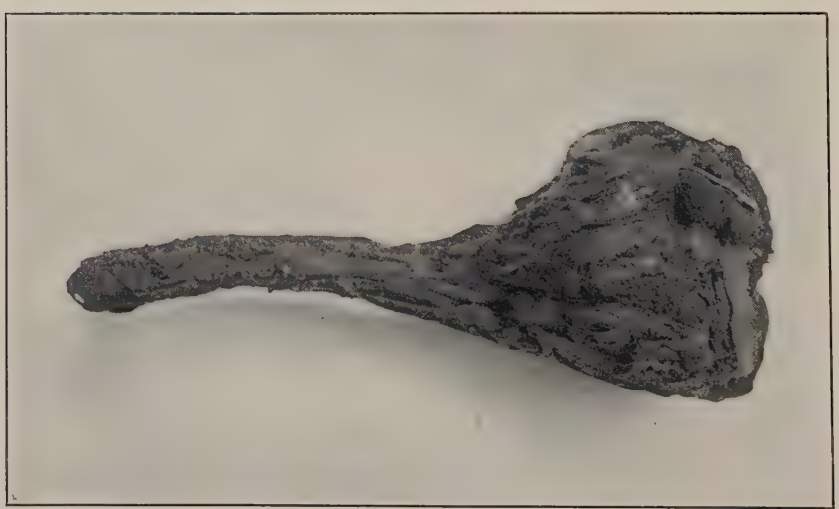
Of the 49 cases collected by me, I find the records of 18, including Barling's 3 cases. Of these, 9 survived the operation from two to fifty-four years; 8 died from a return of the disease in from eleven days to five months, and 1 died within three months from fracture of the skull.

From a study of the reports of cases one must be impressed with the utter improbability of arriving at any satisfactory conclusion as to the ultimate results in these cases, and whether, with the high mortality, operation is justifiable. Barling[3] says: "In estimating the degree of malignancy of these growths of the clavicle, one is hampered by the absence of exact information as to the nature of the tumor and as to whether it arises from the periosteum or the

[1] Annals of Surgery, 1903, vol. xxxvii.
[2] British Medical Journal, March 15, 1890, p. 598.
[3] Ibid.

FIG. 1.

FIG. 2.



medulla of the bone. I think, however, that the details I have related are sufficient to show that the immediate mortality of excision of the clavicle for growths is not so great as might have been anticipated, and that the prognosis as to recurrence and dissemination is better than it is after amputation for sarcoma of the bones of the lower extremities."

It is remarkable how little deformity follows in cases which recover from the operation, and how little impairment of function results, and how rapidly function is restored. In Travers' case "the boy had complete power over his arm in all directions, and only a few months after the operation was amusing himself by rowing on the Thames."

Jesset's[1] case "eleven weeks after the operation had perfect motion of the arm in every direction, being able to play the piano, dress her hair," etc. Britton's case, a coal heaver, "was able to use his pick as well as ever, and could carry heavy weights on the shoulder from which the clavicle had been excised, while on the sound side he had no such power." Caddy,[2] speaking of the result in his case, says: "The movements were perfect, and, being a well-drilled man, he took care that his right shoulder should never drop, so that when clothed no one could notice any difference in the two shoulders; this was probably due to the fact that the outer third of the clavicle being left behind the clavicular attachments of the trapezius and the deltoid muscles were not interfered with." In my case the patient could move the arm more or less freely when she left the hospital, but it was too soon to determine what would be the result as to restoration of function.

The patient, a young woman, aged eighteen years, came under my care in the hospital on February 2, 1904, giving the following history:

No hereditary disease in the family known; habits good; had usual diseases of childhood, without bad results; was never very strong or healthy. Last July, after an attack of measles, felt pains at the sternal end and along the sternocleidomastoid muscle on the

[1] London Lancet, June 8, 1889, p. 1128.

[2] New York Medical Record, November 19, 1892, p. 587.

right side. About two weeks later she noticed some enlargement. The part continued painful, with occasional sharp, shooting pains. The tumor increased slowly until about two months before coming to the hospital. It then commenced to increase rapidly, and when I saw her the growth extended from near the middle of the clavicle and stood 5 cm. above the surface and was 10 cm. in length, while it measured downward 9½ cm. and obliquely 9½ cm.

Physical examination revealed nothing abnormal. Urine examination normal. Blood count: white corpuscles, 7440; red, 4,160,000; hæmoglobin, 45 per cent.

The operation was done on February 8th, and required forty minutes and one ligature. The patient made a good recovery, and left for home February 20th.

While in the hospital she had pains involving the sciatic nerve, which led us to suspect a possible involvement of the cauda equina, which proved to be a correct conclusion, as these pains increased to such an extent as to require three grains of morphine daily.

Dr. Jones, who had charge of the case, wrote me that the patient died on April 26th, the tumor having returned at its original site, with metastases in the frontal and occipital region of the scalp and in the inferior maxilla, and probably in the spine.

[Since writing the above, Dr. J. C. Morfit, of St. Louis, has removed the entire clavicle, the upper portion of the sternum, and the sternal end of the first and second ribs for osteosarcoma of the sternum and the sternal end of the clavicle. The operation was done on August 4, 1904, and up to this time (August 11th) the patient is doing well.]

THE SUBTLE POWER OF RADIUM.

By ROBERT ABBE, M.D.,
NEW YORK CITY.

Assuming that few members of even so prominent a group of American surgeons as comprise this Association have been able to secure specimens of the strongest radium by which to judge of its value to medical science, it gives me pleasure to put on record such observations as I have been able to make, during fifteen months, with the best radium made by the laboratory of the Curies in Paris. I was able, by cabling a very early order, to get fifteen centigrammes ($2\frac{1}{4}$ grains) of the strength 300,000, which was part of the larger amount used by them in their experiments for calorimetric determinations (now historic).

With this and other strong specimens obtained later, including one of German manufacture, denominated a million activity, I have been able to verify most of the interesting work of the foreign observers and to add some of my own, which will be of special interest to this audience.

Omitting the historic and almost romantic narrative of research and discovery of radium, we may start at the point where M. Curie delivered to M. Danysz, of the Pasteur laboratory, a few grains of the same strength as that which it has been my pleasure to use, for the purpose of animal experimentation.

In the early spring of last year the first report was made by him to the French Academy. For the purpose of my paper I will merely abstract a few statements.

If the radium sealed in its glass tube be placed in contact with human skin for three hours, more or less, it produces a painful

burn, followed by sloughing and slow cicatrization somewhat like the Roentgen-ray burn.

With animals, the guinea-pig being specially susceptible, the hair falls, and burns follow on the skin. If suspended some inches above young mice, a week old, they are soon killed, exhibiting these symptoms, after three or four hours: irritation, followed by "dopy" condition, progressive paralysis of their hind legs, convulsions, and death. Examination shows congested and inflamed brain and spinal cord.

When seeds are exposed to radium for a few days before planting they either do not grow or show feeble power.

When two groups of meal-worms are placed in jars, in one of which radium is suspended, many of the radiumized worms die; but those which live on, show such retardation, that, while those of the control test pass through the cycle of life, becoming beetles, which lay eggs which grow to worms during the allotted three months, and repeat this cycle three or four generations, the radium worms still remain meal-worms, veritable Methuselas, as it has been said.

While these experiments were going on a sufficient amount was furnished also to M. Danlos in the hospital, and experiments were conducted which showed a strong curative power over lupus and superficial epitheliomas, with even destructive effect when too long exposed. These results resembled those of Finsen light and Roentgen rays, but were more inexplicable, as they seemed to emanate from a spontaneous indestructible unlimited source emitted by the radium salt through its glass tube.

My own experience has been largely in an experimental therapeutic line, in application to some 40 cases of types of disease illustrating mostly its action on superficial morbid growths.

Time permits mention of only a few. First and simplest of all, I would like to record a fact which I have not seen mentioned elsewhere, that the ordinary wart (verruca vulgaris), no matter how long existing, has disappeared in all 5 cases where I have applied radium by laying it in contact for an hour from one to four times. In three or four days a pink zone appears about its

base and it begins to flatten, and usually disappears inside of ten days, leaving a smooth skin.

This illustrates the retrograde action in morbid cell growths, which may also be seen in tumors of lupus or malignant type.

I am able to show you a photograph of an ulcerating lupus of the temple in an elderly subject which I had been treating for eight years, with the usual result of brief cures and recurrences. One year since he presented himself after a year's absence with a worse condition than ever. I covered the sore with gutta-percha tissue and held the radium tube against it by bandage for an hour and a half. He went to his country home, and I did not see him for a month. Then he presented himself entirely healed. I am able to show you the photograph taken before and after.

In one case of a most painful and intractable epithelial ulcer of the ear, spreading during two years and eating away the upper rim, I tested the comparative action of Roentgen rays *versus* radium. The ulcer was an inch long by a half-inch wide. I covered half by lead plate and exposed the other to radium for half an hour; then at the same seance I exposed the other half to *x*-rays for two minutes.

Repeating this every other day I found rapid healing under both methods. On both, the hard edges flattened, the ulcer filled with pink granulations, and newly cicatrizing skin appeared at the edges. By the sixth time the radium was ahead in its efforts, and islands of new skin appeared half healing the sore. After two applications more, however, the *x*-rays had caught up and gone ahead. The patient being anxious to leave town (this being June of last year), I gave a few more two-minute applications of *x*-rays and sent him home to the country. The ulcer very soon healed completely, with soft cicatrix, and has never shown the slightest tendency to recur.

Three months later I took this cast, which you see shows the contrast with the other one taken before radium treatment. On the second cast you notice a thick red spot one-third inch long on the lower portion, which the patient says is just like the one above as it first began; but he has one also on the other ear.

It would not be possible to find two coincident growths more alike, and they gave me an opportunity to compare radium with *x*-rays in different localities. To one I applied my radium half an hour, to the other *x*-rays as before (two minutes). Three applications of each caused absolute disappearance of both. For three months nothing could be seen on either ear. Then the *x*-rayed spot showed a little thickening which one application of two minutes cured for good. The radiumized spot has never come back. One year has elapsed and his ears are without a blemish.

To turn to large malignant masses, I am able to show you two casts showing positive results of radium only. Along the scar line of an operation done two years before by me for cancer of the breast there came three small nodules in a line which grew to represent the size of a man's thumb.

I laid the radium tube upon these every other day for an hour, a different place each day. On two occasions a blister formed, but quickly healed. All three masses slowly reduced in size until after three months (twenty applications) I took the second cast, showing the growth only about one-quarter the original bulk. A retrograde action had everywhere supplanted the progressive growth.

I now desire to record one more marked illustration of the power of radium, and one which gives me greater hope of its utility in surgery than any illustration I have seen.

A lad of seventeen years came to me eight months ago with a soft tumor of the lower jaw-bone bulging within and without. It replaced the substance of the bone, except its lower border, from the middle line toward the left for an inch and a half. In thickness it was one inch, and in vertical measurement the same. Two incisor teeth and the canine were so loosely embedded in it that one might have pulled them out by a string. Pressure of one finger under the tongue and one outside gave a soft and almost fluctuating sensation. On the inner side an ulcerating surface rose half-way up on the teeth, and from this a deep piece was cut out for microscopic study. It revealed a giant-cell sarcoma. Two submaxillary lymphatics were felt in the neck.

From a surgical point of view it could only be looked upon as a tumor of great malignancy, as it had grown but two months, and under usual procedure would have required the mutilating operation of excision of at least half the lower jaw.

I decided to give trial for at least two weeks to radium treatment, and continue if anything hopeful followed.

Having taken casts, photographs, and measurement for identification, I attacked the portion under the tongue first as being most accessible to watch and as presenting an ulcerated surface, the area of one's little finger-nail, on a soft mass growing inward.

I used two grains of French radium (300,000) in its glass tube laid upon the part inside the teeth, with a bit of lead plate to protect the tongue. After four applications of one hour each every alternate day a marked change was shown. The purple exuberant ulceration grew pink and small, and the whole soft internal tumor was shrinking. After the eighth application the entire interior portion had flattened and become hard. At irregular dates during the next two weeks I made brief applications to this inner aspect.

The effect was so encouraging that I now attacked the outer part. The radium was laid between the gum and lip, but blistered the mucous membrane.

I then determined to plunge it directly into the tumor, fearing, however, that its radiation would be lost in the circulating fluids, as shown by animal experiments in France and Germany, and by myself in the laboratory of St. Luke's Hospital.

It is usual for a tube of the strongest radium when sterilized and embedded either in muscle, cellular planes, or peritoneum of an animal, to be encapsulated and apparently inert for from one to three months. I ventured, however, to pierce the tumor by a fine knife placed in front of the teeth and thrust vertically to the lower bony shell. The tumor was uniformly soft, so that the knife penetrated almost by its own weight, and when it was withdrawn blood flowed freely, but was checked when the radium tube was pushed into the knife channel. The tube was half-filled by the radium, which occupied nearly an inch in length, and was

therefore all buried in the tumor. I left the radium *in situ* three hours. On its removal a piece of gauze with powdered boric acid rubbed into it was laid over the spot and held there for ten minutes.

The treatment was repeated three times weekly for fifteen times. During this period there was a slight but progressive reduction in the bulk of the tumor. Twice I allowed a long interval to elapse because I saw an inflammatory swelling, which at once quieted.

The thrust of the knife was usually made at a new point, and it was most interesting to note a gritty feeling of ossification beginning in some places, and less hemorrhage as shrinking progressed.

Daily the loose teeth became firmer and stood straighter in their places, which corroborated my feeling of satisfaction up to eight weeks of treatment.

Then was noticed a dry black spot near the canine teeth, which spread until a central piece of the tumor sloughed, leaving a cavity, but not affecting the teeth.

Finally a severe grade of inflammation attacked the skin over the tumor and also the half lip, producing a brawny swelling unlike infection, but like the inflammation seen in applications of radiant energy elsewhere. This appeared three weeks after the last application of radium, and was so severe that I feared I had done too much and that an external slough would result.

A soothing lotion controlled it, however, and after four days it rapidly subsided. During the succeeding four months no treatment has been given, and retrograde shrinkage of all the peripheral remnant of the original growth has followed, with progress toward an apparent cure. The teeth remain firm. The walls have retracted to nearly a natural line and ossific changes have established themselves. A recent examination of a small bit punched out of the centre with difficulty, still shows giant-cell element however. This is of great interest and will be spoken of later.

Meanwhile two considerations of the action of radium on growing cells may occupy our attention as they enter into the discussion of the action of this unique force.

The first is its effect on growing seeds. The second a microscopic study of its action on malignant cells.

A photograph of seeds grown for two weeks after being in contact with the tube of radium for four days, and two days before planting, shows that plain seeds grew seven inches tall, radiumized seeds (two days) grew five inches, radiumized seed (four days) grew three inches.

To study the immediate effect of radium on cancer, under the microscope, I made this careful experiment:

A mammary cancer required amputation, the breast presented a solid growth and two secondary superficial flat nodules each a half inch in diameter. One week before operation I laid the radium tubes on sound skin within the field of operation for twelve hours and obtained a lively effect.

On each of six days I chose a different place, once over a secondary growth and once by direct thrust into the substance of the tumor, where it remained for twenty-four hours. The entire series was then submitted to careful pathological study after amputation, with these results:

On healthy skin complete superficial necrosis of the skin took place, with evidence of deeper inflammation shown in leukocyte infiltration into the cellular tissue and about all the vessels and nerves, with some thrombosis of the small vessels.

Where the superficial cancer area was, there was a marked change. Dissolution and retrograde change in nests of cells near by the radium and less at a distance.

Where the radium was thrust into the tumor, sections were made at right angles to the line of the tube, and a marked sphere of influence was uniformly shown for a quarter of an inch on all sides, the nests of carcinoma being unchanged outside that limit as far as could be seen, but within it there remained none but degenerated and disappearing cells. What would have been the result had the pathological change gone on cannot be said as regards that specimen, because the operation had ended what retrograde changes had been initiated.

To supplement this research, however, I have removed one of

the three masses in the patient noted in the early part of this paper who has had treatment for three months. This mass, which had shrunk to one-quarter the size under radium, showed structure of malignancy still, but with predominance of fibre structure.

What, then, is my conclusion from the above observations? It is this: Those malignant cells which have escaped destruction and retrograde change show a striking quiescence, which may mean death of the vital force which makes them malignant. In this connection we cannot fail to be reminded of the seeds which do not grow and the meal-worms which are arrested for an indefinitely long period.

We do not know what constitutes the malignancy of cells. It may not be of germ origin, but merely the erratic and disorderly growth of cells, which have lost their innervation and grow wildly. A regenerating power may be supplied by the so-styled bombardment by particles of radium atoms carrying each its charge of negative electricity. This must be, as yet, speculative.

The element of heat production is certainly not enough to produce destruction, but an effect, such as is shown by Roentgen rays such as seems capable of setting up an inflammation of an entirely unusual type, irritative rather than bacterial, is certainly produced; and whether extreme stimulation is the cause of destruction of some cells and moderate stimulation the regenerating effect on others to bring them into the line of orderly growth again, will have to be shown by further study. Bactericidal action of radium seems to me to be too feeble and inadequate to account for all we have seen.

It stands proven, then, that we have to deal with a very subtle force, unlike that of Finsen light or Roentgen rays, though strongly resembling them in effect, and efficient in some cases where these fail. The Becquerel rays given off by radium may be rated as much stronger than Finsen light as they are weaker than Roentgen rays. It is to be hoped that larger amounts of strong radium may be available for many observers of larger opportunities to aid in furthering research.

DISCUSSION.

Dr. W. W. Keen, of Philadelphia.

One positive fact is worth a dozen negative ones, and one cannot get away from the facts presented by Dr. Abbe and others in the use of radium. On the other hand, we ought, I think, to report the unfortunate or negative results as well as the positive ones.

I have had an experience now covering twenty-two cases with the use of radium. Whether it be due to a difference in the quality of the radium, a difference in the character of the growths, or my method of using it, or what not, I do not know; but to sum up my experience I will say that in not a single case has there been the slightest benefit with the exception of one symptom, and that is pain. Unquestionably, in cases of carcinoma the patients have suffered far less, and, in fact, in a large number the pain has almost or even entirely disappeared. In one case of tic douloureux, involving the inferior dental nerve, the man left the hospital in about a month practically entirely well. In the course of six or eight weeks he wrote to me, stating that he had a recurrence of the pain. I wrote him to come to the city again for treatment, but I have heard nothing from him. Whether the pain has again disappeared or not I do not know, but if it were very bad he probably would have returned.

I have not had any of the French radium of the Curies, but only the German radium. Some of my specimens have been from 17,000 radioactivity upward, until finally I was able to obtain one specimen of 1,800,000 radioactivity. It was a small amount, 10 mm., I think. Dr. Abbe tells me that he thinks the French radium gives better results. A number of my failures possibly were due to the cautiousness with which I used it at the beginning. Not knowing the effect of it, and not being willing to subject patients to any harm, I began with an exposure of ten minutes once every two days, but by experience I found I could be more bold, and in some later cases I have used it for an hour twice a day for a number of days in succession. In two cases of carcinoma of the breast, one an ulcerated carcinoma the other non-ulcerated, which after exposure to radium I amputated, I have not yet received the microscopic report, so that I cannot tell what the pathological results were.

Dr. Abbe. The power of this agent (radium) in many cases in which I have tried it is negative. For instance, in cancer of the tongue I have

failed with it. I have presented to the Association the results actually obtained in certain cases, and I think they are suggestive from a pathological as well as scientific point of view.

With our present knowledge, however, I would not match radium against the *x*-ray, as in my opinion cases of large, ulcerating carcinoma of the breast should be submitted to the *x*-ray and not to radium.

A CASE OF NEPHRITIS TREATED BY DECAPSULATION AND NEPHROTOMY.

By ALEXANDER HUGH FERGUSON, M.D.,
CHICAGO, ILL.

Mr. J. M. D., an attorney, aged fifty-eight years, of Marianna, Lee County, Arkansas, referred by Dr. W. H. Deaderick, presented himself at the Chicago Hospital on February 25, 1904, complaining of (1) frequent urinations and voiding small quantities of urine each time; (2) general weakness, unable to walk a hundred feet without great fatigue; (3) disturbances of the gastro-intestinal tract, indigestion, eructations of gas from the stomach, distention of the bowels, and general abdominal tormina; (4) cough of long standing and shortness of breath; (5) œdema of face, hands, and feet; (6) pain and tenderness in region of both kidneys; (7) attacks of "smothering spells" for ten years, now attributed to kidney disease, and had recently nearly lost his life from six weeks' illness. He was apprehensive, and so was his physician, that another acute attack engrafted on his chronic nephritis might terminate his existence. His habits were more or less irregular for many years. During the last year he lost 25 pounds in weight (140 pounds now, formerly 165 pounds), and became incapacitated to perform his daily work. In his early days he was strong and robust, had diseases of childhood without apparent sequelæ, except a slight cough since two and a half years of age, following measles. In 1875 a severe attack of typho-malaria subsided with the usual treatment. In 1876 he suffered from hæmaturia of short duration, but with distinct renal colic. In 1891 had la grippe, and every winter since then he has suffered more or less from it, which invariably aroused the chronic cough

to troublesome activity. About 1894 his present trouble began with "asthmatic attacks," so called by himself, occasional pains in the region of his kidneys, secretion of irregular quantities of urine, and often urination was too frequent, and accompanied with shortness of breath on slight exertion. These symptoms and signs became more and more pronounced, and œdema of the face made its appearance in the summer of 1903; but not until the 1st of September last did he consult his physician, Dr. Deaderick, at which time the urine was abundant and loaded with albumin and casts, granular and hyaline. His condition became worse in spite of skilful internal medication and management; the œdema extended to the limbs, penis, and scrotum, the latter very marked, and ascites set in (measured forty-seven inches around the abdomen, normal girth being thirty-nine inches). On January 10, 1904, he was compelled to stay at home, and became dangerously ill with undoubted Bright's disease. The acuteness of this illness lasted for three weeks, during which time his prognosis was very unfavorable, the urinary secretion diminished to six or eight ounces in twenty-four hours, and was almost solid with albumin, and casts were present in abundance. The scrotum and penis were tapped twice, and over a couple of pints of serous fluid removed each time. The fourth week showed some mitigation of his symptoms, and the urine with less albumin flowed more continuously into the bladder, as if the many obstructions in the tubuli uriniferi attempted to gradually clear away and the multiple little fountains, the glomeruli, to once more fill and again empty themselves in an endeavor to regain normal functional activity.

What was mostly desired, a speedy recovery, did not ensue. During the next two weeks he showed little or no improvement. Then he left his home and came to Chicago, accompanied by his physician. The journey and hope of his relief appeared to do him good physically and mentally. His family history is negative.

A *physical examination* revealed considerable ascites and œdema of the face, hands, and feet. His walking was irregular and slow. Skin dry and hard, with dilated capillaries. Reflexes,

superficial and deep, were retarded; muscles weak and tire easily. Pulse, 80 per minute. Tension increased and artery stiff. The sphygmographic tracings taken showed the tidal wave well developed and prolonged, and the aortic notch above the base line. The heart was enlarged. The apex beat down and to the left, but not strong. The systolic sound accentuated, the diastolic weak.

Respirations 20 per minute while in bed, and often 30 to 35 when standing. Sometimes gasps for breath, but not Cheyne-Stokes in character. The temperature was 97.6°. His digestion was fair and bowels tardy. There were no marked nervous disturbances and eyesight was good.

Urine. He voided 29, 10, 18, and 47 ounces each twenty-four hours for four days before the operation. The increase to 47 ounces the twenty-four hours before operation was due no doubt to hypodermoclysis of 500 c.c. of salt solution twice. A.M. and P.M. specimens were examined, with the following average result: quantity in twenty-four hours, average per day, 26 ounces for four days; specific gravity, 1018; turbid and color intensified; acid in reaction; total solids, 14.26 grams in twenty-four hours; urea, 2 per cent., 6.8 grams in twenty-four hours; albumin, 9.5 per cent. bulk; indican increased, and a trace of bile. Microscopic examination revealed (*a*) blood in one specimen, but it was passed after the ureters were catheterized; (*b*) leukocytes, a few in each field; (*c*) crystals, a few; (*d*) debris, a moderate amount; (*e*) bacteria always present; (*f*) epithelial cells present; (*g*) cylindroids never absent from four or five in field; (*h*) casts, both hyaline and granular, in abundance, nine to thirteen in the field; (*i*) chlorides increased; (*j*) sugar not present at any time.

On February 29th both ureters were catheterized, and three hours' secretion from each collected. The left kidney yielded 10 c.c. and the right 30 c.c. during that time. The chemical and microscopic examination of these two specimens showed the left kidney to be probably more diseased than the right, containing as it did more albumin and casts, but otherwise the findings were the same as above mentioned.

Dr. Deaderick kindly furnished me with many examinations of the urine during the patient's illness, which were practically the same in character as found by myself.

A blood examination was made, and it was found to be nearly normal, showing only slight anæmia.

A diagnosis was made of chronic interstitial nephritis, with myocarditis and arteriosclerosis. If treated medically the prognosis was evidently hopeless. An operation was recommended, with a hope of temporary if not permanent relief.

Operation (March 1, 1904). Chloroform by spray method was given. A straight posterior incision was made. The left kidney was rapidly decapsulated and then a regular nephrotomy performed. A rubber tube surrounded with plain gauze was inserted into the pelvis of the kidney, and the wound closed except at its upper angle, where drainage was inserted. The kidney was somewhat smaller and firmer than normal, with a capsule irregularly adherent and thickened.

The short time he was anæsthetized manifested that his heart could not stand the anæsthetic for many minutes. He was blue in the face, and his pulse became weak and intermittent. About a drachm and a half of chloroform sufficed.

He left the operating-room with a temperature of 98.2°, pulse 90, and respirations 22. A thirtieth of strychnine and 500 c.c. normal salt solution were forced beneath the skin while I was operating. His was a case that required rapidity of action.

Post-operative Treatment and Progress. A little hot water by mouth occasionally and $\frac{1}{30}$ grain of strychnine every four hours, hypodermically, was the order to the nurse. He complained of a pain in the back, and passed a restless night. At 5 A.M., following the operation, he had a temperature of 101°, pulse 94, and respirations 30, and four hours later the temperature was 99.8°, pulse 90, and respirations 24. Twenty-four hours later his temperature was normal, pulse 86, and breathing 24 times to the minute.

The dressings were changed every four hours for four days. They were saturated with urine each time, especially during the

first forty-eight hours. The rubber tube was removed on the eighth day, and the gauze replaced on the eleventh day, and every day thereafter for a week. No urine appeared in the dressing after the twelfth day, and after this time the wound was allowed to close. It is worthy of note that the patient expressed himself as feeling "a new man" a few hours after the operation. I have noticed that nearly all cases of decapsulation soon afterward express their sensations by saying "the operation has done me good already," or something to that effect, and, too, the clinical phenomena begin to vanish.

The first twenty-four hours after the operation, with all the urine from the left kidney draining externally into the dressings, he urinated 20 ounces, which of course came from the right kidney. Why this sudden improvement? The urine was collected and examined every day for the next eighteen days, and the quantities were as follows: 20, 28, 28, 30, 22, 27, 31, 40, 39, 53, 41, 57, 56, 48, 60, 67, 57, and 67 ounces. Blood appeared in the urine for ten days. An examination of it March 11th showed it to be clear and the color amber. Specific gravity, 1020; acid; urea, 0.8 per cent.; bile absent; hæmoglobin absent; albumin absent; no sugar; casts, two hyaline on the slide. No leukocytes, no blood, and no bacteria. The next day's examination showed no casts at all. While in the hospital after this to the 25th of March, the urine remained normal. After returning home Dr. Deaderick collected and examined the urine every day from March 29th to April 14, 1904, and forwarded the reports to me. The quantities each day were: 28, 22, 24, 29, 51, 39, 51, 48, 36, 39, 26, 52, 38, 44, 31, 33, and 39 ounces, making an average of a little over 37 ounces in the twenty-four hours. On March 29th a trace of albumin, leukocytes, and bile were present; specific gravity was 1016; urea, 1.6 per cent., but no casts. On April 5, 1904, a trace of albumin was again found and a few granular, hyaline, and epithelial casts made their appearance, but five days later (April 10th) the report shows no albumin and no casts.

Another sudden improvement was in the heart; its sound and action became apparently normal in a week after the operation.

The sphygmographic tracing of the radial pulse showed less arterial tension.

For a further study of his case, the patient returned to the Chicago Hospital, and for two days (April 20 and 21, 1904) the food and drink ingested were weighed and measured.

For Breakfast.

Orange.

Oatmeal and Cream. Toast and Butter.
Steak. Boiled Potato.

Coffee.

For Dinner.

Soup.

Steak. Mashed Potato.
String Beans. Bread and Butter.
Custard Tea. Cream.

For Supper

Rhubarb.

Malta Vita. Creamed Chicken. Cream.
Baked Potato. Toast and Butter.

Tea

Amount of solids taken in twenty-four hours	57¼ oz.
Amount of liquids taken in twenty-four hours	67 "
Amount of excretion defecated	3½ "
Amount of excretion, urine	43 "

The urine was collected and examined. April 21st, twenty-four hours, 43 ounces, clear, yellow; specific gravity, 1015; acid, 0.8 per cent.; urea; no albumin, no casts, no cylindroids, no bacteria, no indican, no bile. At 6.30 P.M. (April 21st) the right ureter was catheterized and the catheter left in for three hours; urine collected; upon removing the catheter from the right kidney the urine then in the bladder came from the left kidney, and it was saved for examination.

Kidney Operated Upon—Left.

Quantity.	*Right.*	*Left.*
In three hours	40 c.c.	43 c.c.
Color	Amber.	Yellow.
Transparency	Cloudy.	Clear.
Specific gravity	1020.	1015.
Reaction	Acid.	Acid.
Urea	1.1 per cent.	1 per cent.
Indican	A trace.	A trace.
Bile	None.	None.
Hæmoglobin	No.	No.
Albumin	A trace.	A trace.
Sugar	No.	No.
Casts	Absent.	Absent.
Epithelium	Pavement.	Pavement.
Pus	No.	No.
Blood (likely due to catheter)	Yes.	Yes.
Bacteria (likely due to decomposition)	Present.	Present.

The passing of the catheter into the ureter no doubt accounts for the blood and traces of albumin.

The value of catheterization of the ureters enables one to definitely ascertain the functional activity of each kidney as well as to probably form an idea of its condition as far as its excretion can show.

Pathological Report. At the time of the operation a small piece of the kidney was removed for microscopic study. The most of this section was sent to Professor F. Robert Zeit, of the Post-Graduate Medical School and Northwestern University, and he furnished the following report:

"The lining epithelium of proximal convoluted tubules is partially denucleated and necrotic. Whole areas show marked cloudy swelling and some fatty degeneration. Interstitial tissue markedly increased, with dense small-cell infiltration. Here and there contracted, atrophic areas, with compressed tubules and obliterated glomeruli. Glomeruli in these areas are transformed into fibrous globules. Bowman's capsules thickened.

"*Diagnosis.* Chronic diffuse nephritis, with secondary contraction."

Professor Zeit selected six slides, and these were photomicrographed by Carl Theodor Gramm, M.D., of Chicago, and numbered 1, 2, 3, 4, 5 and 6. It is to be seen that marked pathological kidney changes characteristic of chronic interstitial inflammation are demonstrated in each and all of the pictures, and so clearly that it seems to me quite unnecessary to say anything regarding them by way of interpretation.

Patient Presented. I must thank the patient for coming here to present himself, for it gives you an opportunity to see him and judge for yourselves of his present condition. He is here to show his physical condition and functional activity as well as willingly to attest to the highly satisfactory transformation that in him has followed decapsulation and nephrotomy of one kidney for chronic Bright's disease. He has gained 25 pounds in weight, feels better than he has for twelve years, appears healthy, walks firmly and swiftly to and from his office; his former mental vigor is back again, and in fact all the symptoms and signs of his disease have practically vanished. He has no general weakness, nor frequent urinations, nor œdema, nor ascites, nor "smothering spells," nor cough, nor gastrointestinal disturbances, nor tenderness in the region of his kidneys, nor heart irregularities, nor high-tension pulse, nor anything that prevents him from eating any food, working all day, and sleeping every night. "Ecce homo," but not in derision.

While my patient has been here (St. Louis) I have been able to collect the urine that he passed for twenty-two hours, and Dr. G. C. Crandall, of St. Louis, has very kindly examined it and furnished me with the accompanying report. During the time his urine was being collected he ate very heartily of ham, eggs, fish, chicken, beef, mutton, etc. Each meal contained a liberal amount of meat of one kind or another, usually beefsteak.

FIG. 1.

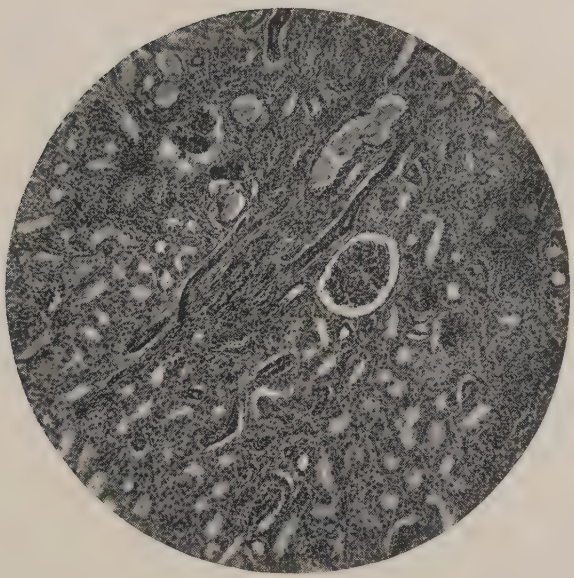


FIG. 2.

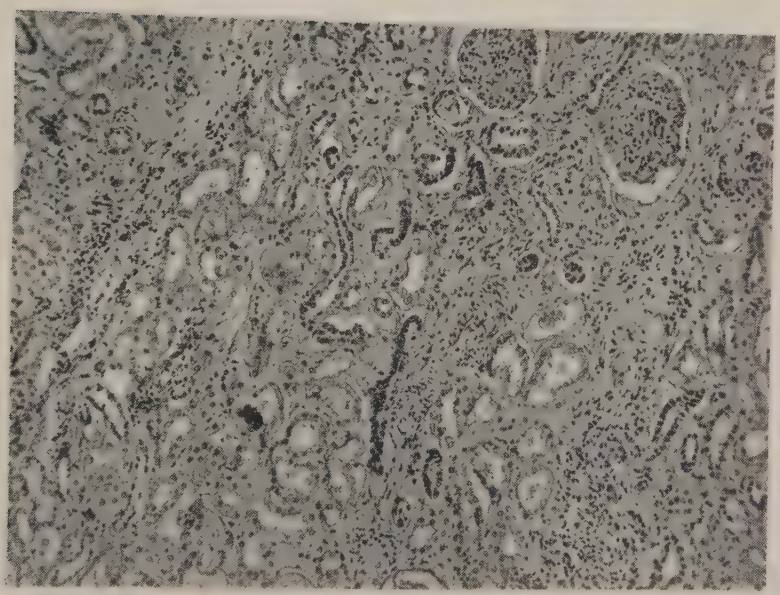


FIG. 3.

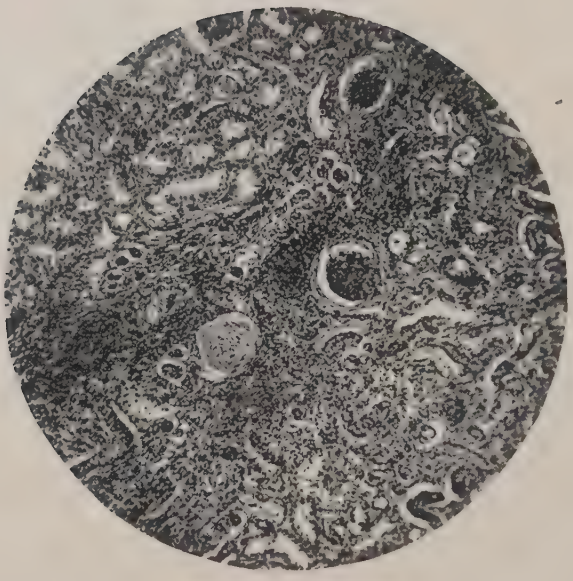


FIG. 4.

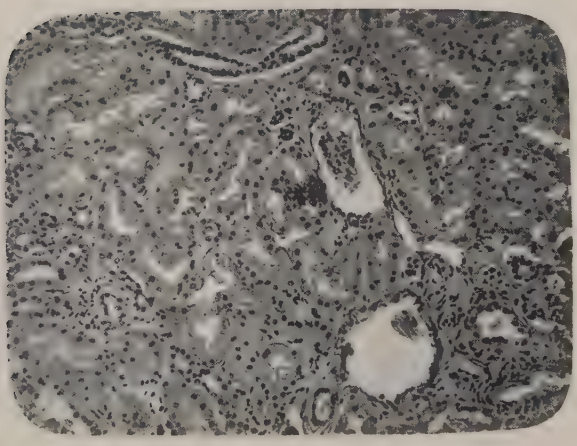


Fig. 5.

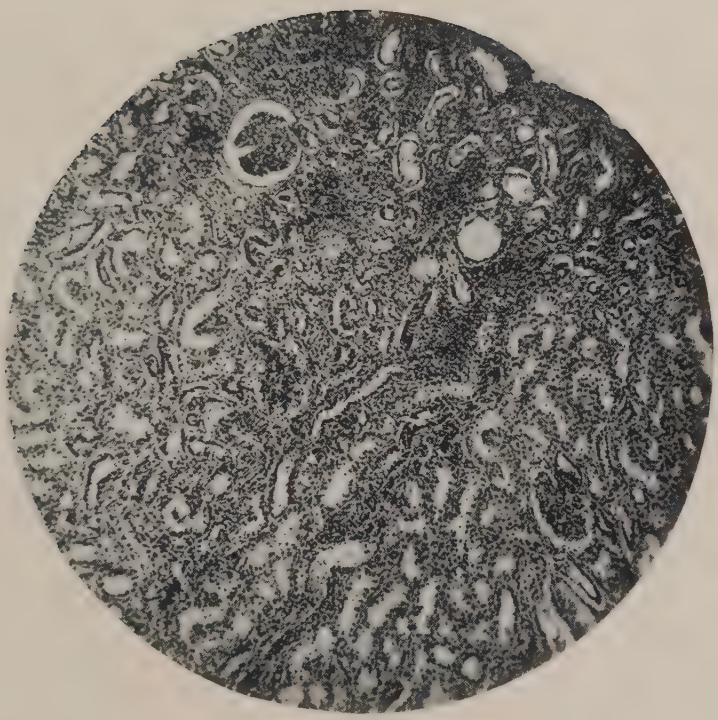
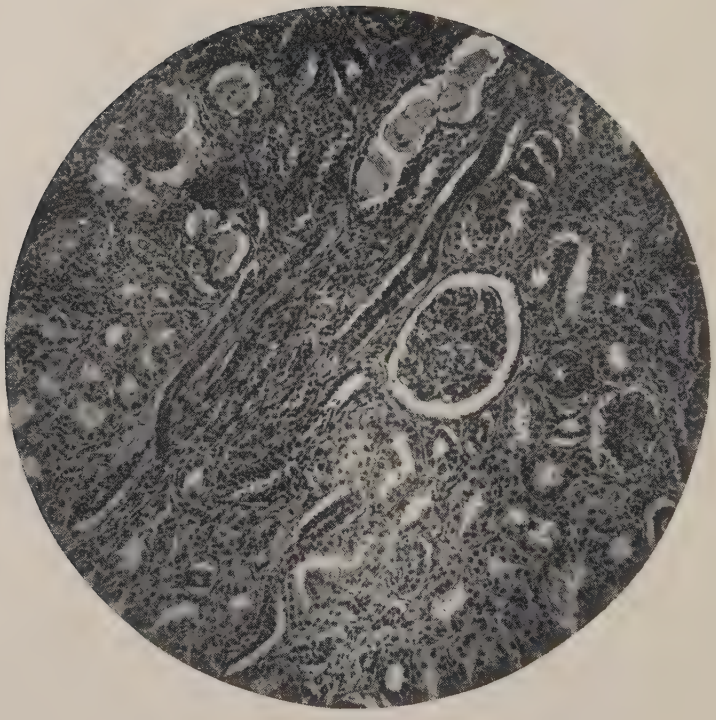


Fig. 6.



St. Louis, Mo., June 17, 1904.

The examination of the specimen of urine (twenty-two hours) you sent me shows the following:

Quantity	1700 c.c.
Color	Light straw, cloudy
Reaction	Acid.
Specific gravity	1016.
Albumin	Trace.
Sugar	None.
Urea	2.1 per cent.
Cylindroids	Few.
Casts	Few hyaline, few granular.
Pus	None
Crystals	None.
Blood	None.
Bacteria (probably result of decomposition)	Numerous.

Since the meeting at St. Louis, Dr. Deaderick has very kindly sent the following:

Marianna, Ark.

Name, J. M. D. Date, July 4, 1904.

Quantity in twenty-four hours, 42 ounces. Color, yellow.

Reaction,	acid.	Specific gravity,	1007.
Urea,	1.5 per cent.	Chlorides,	normal; phosphates diminished.
Sulphates,	normal.	Indican,	increased.
Albumin,	none.	Sugar,	none.
Bile,	moderate amount.	Hæmoglobin,	none.

Microscopic Examination.

Unorganized sediment	Urates.
Epithelial	Few squamous and spindle.
Pus	None.
Blood corpuscles	None.
Casts	None.
Bacteria	None.

I am indebted to Professor W. E. Quine for examining the patient and confirming our diagnosis and also the prognosis on medical treatment; to Dr. Kreissel for catheterizing the ureters; to Dr. R. S. Pattillo for examining the eyes, and Drs. Webb and Gourley for assisting at the operation and carrying out the after-treatment.

The result of the case, up to the present, I do not know how to characterize other than brilliant. Much as I should like to reply to many of the adverse criticisms that from time to time have been made by both physicians and surgeons on this new branch of surgery, I thought more good would accrue from giving scientific and practical data collected not alone from my own observations and work on the case, but also from that of the gentlemen I have mentioned. It is in this as it was in almost every great innovation in medicine, history is repeating itself.

ON CERTAIN RARE AND UNAVOIDABLE CALAMITIES FOLLOWING SURGICAL OPERATIONS.

By MAURICE H. RICHARDSON, M.D.,
BOSTON, MASS.

I HAVE selected this subject, first, because I wish to hear what the experience of others has been in these distressing calamities, and if possible to get some help in trying to avoid them; and, furthermore, because the subject has been of extreme interest to me. I present these cases, too, for the benefit, and perhaps comfort, of those who have not yet encountered such calamities; but to whom it is only a question of time when they will come.

Finally, it seems to me that we all should at times be reminded that surgery—brilliantly successful as it has become by the extraordinary advances of the past quarter-century—is still attended by certain unavoidable risks; that disasters may occur in the cases which are apparently the simplest and safest; that they cannot with our present knowledge be predicted or provided against by even the most experienced surgeon; that when they do occur, they occur not as the result of ignorance or neglect, but, as my title describes them, as the *rare and unavoidable calamities of surgery*.

Of the conditions which may predispose to, the symptoms which may portend, the means which may prevent, and the course which may retrieve disaster, we have little or no knowledge; for these occurrences are exceedingly infrequent. The opportunities for investigation in the hands of any one man, or of any one hospital, are, from the nature of things, limited. The possibility of occurrences which I mention must, however, be borne in mind in advising surgical operations, especially in the abdo-

men; for disaster and even death may take place in the cases which are apparently the simplest.

So long as we are human, we must expect occasionally to meet with failure and disaster in the practice of surgery, and that in spite of every precaution. In the great majority of cases failures and disasters may be traced to some error of observation, of judgment, or of technique. In many instances, however, the most rigid review of the case will fail to show the error by avoiding which a similar disaster may be prevented. Disasters occurring as the results of causes which cannot be detected may be classed as unavoidable, and yet in a strict sense they probably are avoidable. The errors will sooner or later be discovered and corrected. Indeed, it would be difficult to imagine a combination of circumstances—however disastrous—which by an accurate foreknowledge could not be successfully provided against.

Let us consider, for example, suppression of urine after a hysterectomy, when that operation has been decided upon after careful observation of heart, lungs, and kidneys. Even if everything favors operation, it is not unheard of for patients to have complete and fatal suppression of urine. Such a calamity is exceedingly rare, it is true; yet it undoubtedly does occur. If ether has been used for anæsthesia, it is common to say that ether caused the suppression; and that if chloroform had been used no renal changes would have followed, and therefore no suppression. I do not believe that ether alone is often responsible for urinary suppression—if, indeed, it ever is; and yet ether is usually said to be the cause of this accident. Assuming that ether is responsible, we may say that chloroform would not, on the chances, have caused death from suppression, and that the disaster was therefore avoidable. But if chloroform had been used, the patient would have run even greater risk from the lethal effects of chloroform itself. In the case in point, there being no way of determining beforehand the patient's idiosyncrasies, suppression of urine in such cases may be regarded as an unavoidable calamity.

The disaster of infection of the knee-joint, general septicæmia, and death, following arthrotomy, is clearly owing to an infection

from without; and infections from without are, in a strict sense, avoidable. But are infections of wounds always avoidable by any human agency? Can we always determine just that lapse of strictest watchfulness and foresight by which the joint received its bacterial contamination? We all know that we cannot, and that infection will occur at an operation which has been provided for by every care, even as to the minutest detail. In the strictest sense, perhaps, such infections are avoidable; in the practical, every-day construction of the word, they are unavoidable. The operation may have been performed upon a dusty day, and particles of germ-laden dust may have drifted into the wound; the skin incision may have infected the knife, and that the joint; the patient's phagocytic powers may have been feeble—in a word, the joint may have been infected in any one of a thousand ways, all of which, theoretically avoidable, are unavoidable by human foresight. Nevertheless an infection is lightly condemned by some as in itself conclusive evidence of blundering or carelessness. A certain percentage of infections must be regarded as unavoidable, no matter how confident in the perfection of his technique the surgeon may be.

Then there is the disaster of post-operative hemorrhage—one of the most formidable and distressing calamities of surgery—who can predict when it will occur? Who can by taking thought always avoid it? And yet the disaster of hemorrhage should rightly be regarded as among the most easily prevented of all post-operative disasters. Who could predict—much less prevent—a hemorrhage from the vessels of the lesser curvature of the stomach following a cholecystostomy for jaundice? Such a disaster occurred, after simple tube drainage through the gall-bladder, in the case of a strong man of fifty-seven years who had been jaundiced for two or three months. Hemorrhage was, of course, feared, and every provision possible was made for it. The blood coagulation time was brief; there was no hemorrhage at the operation. On the third or fourth day after operation, however, oozing from the wound began, and continued in spite of all that could be done. Secondary operation seemed successful,

though no source of the bleeding could be found. Autopsy showed that the blood came from a vessel of the stomach at the lesser curvature, far from the operative field. Death was welcome in this case, however, for the cause of jaundice was cancer of the pancreas.

Who by experience, forethought, aseptic technique, and operative skill can make sure that in no case of hydrocele, varicocele, or hernia, either from hemorrhage or from infection, will the integrity of the testicle be threatened? These accidents, too, are in a strict sense avoidable; but is it not too much to expect of human frailty that they can in every instance be actually prevented? I have no doubt that the surgery of the future—no matter how perfect it may become—will always be attended by such disasters as I have mentioned.

It is not, however, to consider technical errors—slipping of ligatures, infection of joints, sloughing of testes; or errors of carelessness and of observation, all practically or theoretically avoidable—that this communication is presented; but rather to consider a certain class of accidents which are not even theoretically avoidable. Chief among these are changes in the blood which result in venous thrombosis and in death from pulmonary embolism.

Phlebitis following abdominal operations is not uncommon; and it is an accident which, as far as my observation goes, is practically unavoidable. Indeed, I believe that it is theoretically unavoidable. Perfect healing by first intention—without evidence of sepsis in pulse, in temperature, or in blood—by no means ensures the patient against phlebitis. The clinical picture of post-operative phlebitis is, unfortunately, only too familiar to the experienced surgeon. There is, in the great majority of cases, every appearance of aseptic wound healing; there is no local infection; there is no constitutional disturbance. Indeed, the signs of phlebitis do not usually appear until the patient is ready to leave her bed. Then we have the painful and tender veins, with slight rise of temperature and pulse. The only evidence of bacterial infection lies in these trivial disturbances. It is at once

assumed by some that there has been a wound infection, transmitted to the veins of the limbs through the venous plexuses of the pelvis. Doubtless the thrombosis which affects the left lower extremity may be traced to the seat of operation, though it is hard to see how a right-sided operation like appendectomy should be followed by a thrombosis of the veins of the left calf. This thrombosis may be the result of wound infection, but such an explanation seems to me against common sense and experience. The chief point is, however, that it is unavoidable, either theoretically or practically.

In my experience phlebitis is more common after extensive dissections in the female pelvis—especially in patients who have for a long time been bleeding from the uterus—than it is in any other class of cases. It is frequently a disease of exsanguination, of thin, watery blood. Phlebitis is therefore more common after operations upon the fibroid uterus, whether myomectomy or hysterectomy, in patients who have been bleeding. The proportion of cases is not large, but it is large enough to be regarded as a serious evil effect of operative treatment. Phlebitis occurs most frequently in those patients whose wounds have pursued a uniformly favorable and aseptic course.

Sometimes I have thought that venous thrombosis is the result of enforced quiet—that the patient would have had the complication if she had been put on her back and kept perfectly still for four weeks without operation. I have therefore required my patients to keep their legs moving freely—at no time to keep them perfectly still.

The occurrence of phlebitis after operations upon the uterus or upon the ovaries suggests the extension of simple clotting from the uterine or ovarian plexuses of veins into the iliac vessels. Phlebitis rarely occurs after any other abdominal operation. I have seen but one case of phlebitis after a simple appendectomy (S. H. R., vol. xxx. p. 196); none after a gallstone operation; none after such an operation as ventral fixation. I have never seen a septic thrombosis in the course of any ordinary phlebitis, though in cases originally septic I have

seen a few instances of pylephlebitis and multiple abscesses of the liver.

The common phlebitis is, I believe, aseptic in its origin and in its course. It can never be predicted and it can never be avoided. If this disease has a septic origin, the sepsis is of the mildest form, and too trivial ever to cause signs of local wound infection.

Phlebitis, when definitely developed, does not seem likely to cause pulmonary embolism. It is the sudden detachment of the unsuspected thrombus which causes the disaster. I have never seen an embolus from this source, except perhaps once many years ago, when, as interne, just prior to proposed amputation of the leg, I saw, in a case of long-saphenous phlebitis, a thrombus forced from its bed into the venous current by an Esmarch bandage. The clot lodged in the pulmonary artery, and caused instant death.

The ordinary phlebitis—of which I have seen many examples—is, I am convinced, the origin of pulmonary embolism in an extremely small percentage of cases. If a thrombus forms in a vein as the very first step in the process of phlebitis the detachment of that clot and plugging of the pulmonary artery takes place before the patient shows any local or constitutional signs of phlebitis. As I have already said, the detachment of a clot after the veins have become tender and after the development of slight constitutional symptoms, is of such rarity that I can at this time recall no cases of embolism. When embolism does take place in phlebitis, that embolism is of the multiple form, and that phlebitis of the septic suppurating variety. The small and septic thrombi which become the foci of multiple infarcts in the lungs and elsewhere are a sequel of a form of phlebitis quite different from that under discussion. There is in such cases incontrovertible evidence of both local and constitutional sepsis. The clinical sequence is not easy to determine between two local areas of sepsis—the primary phlebitis and the secondary infarct—between, for example, a presumable sepsis in the uterine sinuses after myomectomy and a fatal septic meningitis.

Recently I lost a patient (O. R., vol. xlix. p. 97), a strong

woman, aged thirty years, after a myomectomy for multiple fibroids. The operation was uncomplicated. There was much oozing, which required many ligatures. A long series of uninterrupted recoveries had led me to look upon myomectomy as an operation safer in practice than in theory. The patient died in two weeks of a septic meningitis. There were no signs of sepsis in the abdomen, but there was unusually marked constitutional disturbance. Whether in the uterine sepsis—if it really existed—there was a thrombophlebitis to which the meningeal disease was secondary, it is impossible to say, for there was no autopsy. But even if no direct connection between the two lesions could have been made out, common sense would indicate that the fatal meningitis was in some way secondary to the myomectomy. A septic uterus after myomectomy is, of course, beyond the scope of the unavoidable calamity and the scope of this paper.

Thrombosis with detachment of clot and pulmonary embolism is a distinct feature of venous complications, and a disaster of such magnitude that it has seemed to me worthy of being considered the chief subject of this paper. But is thrombosis of veins, detachment of clot, and pulmonary embolism *prima facie* proof of a phlebitis? I do not feel convinced that it is. Phlebitis and pulmonary embolism may have a common origin. Clinically, however, the latter takes place before there is even a suspicion of the former. Detachment of clot and plugging of the pulmonary artery precede any symptoms of ordinary phlebitis, and the patient of course does not survive for the demonstration of the latter condition. Patients who die suddenly during an aseptic and satisfactory convalescence after abdominal operations, especially the pelvic, may be assumed, in the absence of an autopsy, to have died of a sudden plugging of the pulmonary artery by a thrombus; for in by far the greater number of cases autopsy has shown this mechanical condition. A careful review of such cases in my experience has shown this cause invariably present.

Sudden death after a serious abdominal operation may be ascribed, then, in almost every case, to pulmonary embolism. No signs, either local or constitutional, precede this accident.

The patient is seized with præcordial distress, oppression, and suffocation—gasps for breath and dies. Sometimes there is a slight attack, followed soon after by a severe and fatal one. At the autopsy a clot is found plugging the pulmonary artery, and often there is no evidence as to the source of the clot. A patient rapidly convalescing dies instantly, and the house of rejoicing is turned into a house of mourning.

In my own experience this accident has taken place only in pelvic and abdominal cases at the Massachusetts General Hospital. I have known a death from this cause to follow an extensive operation for breast cancer. The occurrence is not infrequent in the medical wards.

Pulmonary embolism usually occurs after abdominal operations during which large uterine sinuses are laid wide open. The number and size of these sinuses are often extraordinary. I have found the uterine artery itself, greatly enlarged, concealed in a mass of veins the size of the wrist, each vein a quarter of an inch or more in diameter. The closure of these veins is sometimes by ligature and sometimes by spontaneous blood coagulation. When the uterine artery is isolated and tied, hemorrhage from the veins ceases spontaneously. As there is no afferent supply, there is no efferent flow, especially if the actual cautery is used in cutting through the pedicle and the cervix. In all cases these sinuses are closed either by suture or by spontaneous blood-clotting after ligation of the uterine arteries (which I usually isolate and tie separately in order to avoid the ureters). The clotting of blood varies in different cases. I am inclined to think that the woman who by long-continued uterine hemorrhage has become markedly exsanguinated, is the one in whom coagulation may be most rapid, but in whom the coagula are most easily detached. Her life has perhaps been preserved during her long illness by this tendency of bleeding sinuses to close themselves. Be that as it may, the patient who is anæmic and yellow at the time of operation is the one in whom I am led to fear pulmonary embolism.

Is pulmonary embolism avoidable? Can the likelihood of

its occurrence be predicted? Has it a definite relation to phlebitis?

In my experience pulmonary embolism may occur after the most successful operation and during a perfectly satisfactory convalescence. There is no way of predicting it, and there is no known predisposition to it. The possibility of its occurrence must be remembered, especially when operations not actually imperative are under consideration.

The following cases illustrate some of the conditions under which sudden death has taken place after my operations for abdominal diseases:

Case I.—George E. S. (S. H. R., vol. xxxiii. p. 55), aged twenty-two years, living in Fall River, patient of Dr. W. T. Learned, after a week's illness, was operated upon for appendix abscess on April 28, 1894. The operation consisted of a deliberate and careful dissection down to the cæcum, behind which was found thin, fecal pus. The main cavity of the abdomen was not opened.

While convalescing extremely well, this young man, during the second week, suddenly died. Autopsy showed the pulmonary artery completely plugged. There had been no suspicion of phlebitis.

Case II.—Mrs. Ella C. (S. H. R., vol. xlix. p. 45), aged fifty years, patient of Dr. J. M. Crocker, of Cambridge, I saw on November 22, 1899. This patient had come to Dr. Crocker two years before, complaining of metrorrhagia. I found a fibroid the size of a cocoanut—tender and pressing on the bladder. Hysterectomy was advised. The uterus, containing a fibroid about the size of an orange, was amputated above the cervix with the actual cautery.

The patient rallied from the operation, and everything went well until the afternoon of the fourth day, when she suddenly gasped for air, and died before either nurse or physician could reach her.

The autopsy was performed by Dr. Swan twenty-four hours after death. An extensive thrombosis of the superior cava was

found, with plugging of the pulmonary artery. It was hard to tell where the thrombi began. They were very extensive, and from their character there was no doubt that they had formed before death.

Case III.—Laura C. (S. H. R., vol. xxxvii. p. 38, and vol. xli. p. 153), aged forty years, colored, I saw at the State Hospital in Tewksbury on March 17, 1897. In this case there was a history of a uterine fibroid since 1895. This patient was mildly demented. She made a good recovery from the operation—an abdominal hysterectomy—but four weeks later died suddenly while trying on an abdominal supporter. Dr. Whitney reported that the growth was fibromyoma of the uterus.

Autopsy was made by Dr. M. W. Richardson, who reported as follows:

"Brain shows considerable injection of vessels of pia. Otherwise nothing abnormal noted. Seat of operation apparently in first-rate condition. Kidney normal in shape and size. Capsule peels off fairly easily. Microscopically kidney, though somewhat old for satisfactory examination, shows a considerable increase in interstitial tissue between tubercles, and also thickening of capsules of glomeruli. Otherwise nothing abnormal noted. A moderate chronic interstitial nephritis."

This death was supposed to have been caused by pulmonary embolism, though none was observed post-mortem. The death was soon enough after operation to make reasonable some direct connection between them. If not *post hoc ergo propter hoc*, yet it would be hard to convince one that the death was not in fact the result of the operation. I include this case in the list of unavoidable fatalities, though I admit that there is no direct pathological connection between the operation and the death. In this case the line of suture was perfect; there was not even an adhesion; no operation ever went more smoothly; and yet the patient was not free from danger up to the time of fitting an abdominal supporter preparatory to walking about.

Case IV.—Mrs. Maria R. S. (O. R., vol. xlii. p. 7) aged thirty-four years, of Wales, Mass., thin, pale, and sickly, had a right-

sided tumor, fluctuant and closely attached to the uterus. On December 20, 1902, at the Brockton Hospital, I removed a dermoid cyst with twisted pedicle. The patient died of pulmonary embolism on December 30, 1902.

In this case there was more than the usual non-adherent aseptic cyst; changes had taken place which made the operation extremely difficult and the prognosis grave. The patient did well, nevertheless, for ten days, when she died instantly—without any premonitory symptoms. (Autopsy showed a plugging of the pulmonary artery.)

Case V.—Another case, not abdominal but pelvic, was that of a woman in middle life, a patient of Dr. Henry W. Boutwell, of Manchester, N. H. There was marked exsanguination, owing to a submucous fibroid—in reality a pediculated uterine polyp—removal of which did not take ten seconds. There was no hemorrhage from the pedicle. Within a few hours of the operation the patient died instantly from the lodgement of a thrombus in the pulmonary artery.

Case VI.—A final case was that of a man exsanguinated by bleeding piles, for which a clamp-and-cautery operation was performed. Within twenty-four hours of the operation this man suddenly died—without premonitory symptoms.

In these last two cases the nidus of the thrombus was undoubtedly in the venous plexuses of the pelvis. Both patients were yellow from loss of blood; and, as I believe, peculiarly liable to venous stasis and blood coagulation. I am convinced that in such cases there is from this cause danger enough of serious disaster to be taken into consideration. In cases of this kind, however, operation is imperative—whatever the danger; and when the blow does fall, it is softened by the fact that the family and friends have been warned of its possibility.

In none of these cases had there been any pain in the legs, or any evidence whatever of phlebitis. There had been no disquieting symptoms of any kind, in fact.

Suppression of urine as a sequel of surgical operations is not especially infrequent. In many cases the suppression may be

reasonably predicted; in the rarest instances it occurs unexpectedly, after demonstration of the sufficiency of the kidneys. In some cases it has occurred after operations the performance of which was absolutely essential to the preservation of life, in spite of known renal disabilities—the condition of the kidneys was unfortunate, but the risk of suppression had to be run.

In other cases, happily infrequent, suppression has followed operations of convenience or of comfort, so to speak; operations for the relief of conditions threatening neither life nor—seriously—health. The suppression of urine following myomectomy or hysterectomy for fibroids which do not seriously offend belong to this class. I do not advise the removal of small, non-offending fibroids, however, unless the indications are plain or the diagnosis is doubtful; and even then only when the other organs are perfect.

Suppression of the urine after trivial operation, when the kidneys are found at autopsy to be seriously diseased, is a deplorable calamity, but an avoidable one. Such a calamity cannot occur if routine examinations of the urine are made. My experience has never included a urinary suppression after a trivial operation. I have, however, had one case of suppression of urine and death after a hysterectomy which would not have been performed had the urine been examined (S. H. R., vol. li. p. 65). By a mischance the diseased condition of the kidney had not been discovered, the physician understanding that the surgeon had examined the urine; the surgeon, that the physician had examined it—and both thinking that it was normal.

These cases do not belong in the category of unavoidable calamities; for suppression of urine is, in the great majority of cases, avoidable if operations are not performed upon patients with diseased kidneys. Careful observation of the amount of urine passed in twenty-four hours; the quantity of urea; the presence of albumin and sugar; the detection of casts and other renal elements, will enable the surgeon to avoid these calamities in connection with operations of comfort, convenience, and looks, rather than of necessity. As far as my own experience goes, suppression of urine has occurred but once when the kidneys

were perfectly healthy. Suppression is therefore *prima facie* evidence of renal disease or renal insufficiency.

The limitation of urinary suppression to pelvic abdominal surgery may, as already stated, suggest that in some cases of suppression I may have tied, or in some other way occluded, the ureters. The only operation which can seriously threaten one or both ureters is that of hysterectomy, with the possible exception of removal of a cyst or other tumor deeply placed in the broad ligaments. I have carefully excluded from consideration those cases in which the suppression of urine was immediate and permanent. Such a form of suppression is the only one which can possibly suggest occlusion of the ureters, and such a form I have never had the misfortune personally to encounter. Indeed, when the operation is necessarily in close contact with the ureters, a careful, deliberate dissection which exposes the ureters as an early and indispensable step in the process makes sure that the ureters can neither be tied nor cut without the surgeon's full knowledge of the fact. Rapid blind mass ligation deep in the layers of the broad ligament, followed immediately by total cessation of urinary flow, is in itself proof that both ureters have been occluded. If care is exercised, however, such a disaster is, of course, as unlikely to occur as are injuries of the pneumogastric, phrenic, or recurrent laryngeal nerves in dissections of the neck.

Of all post-operative disasters the most distressing and deplorable is hemorrhage. It has been only after operations upon the gall-bladder, in my experience, that uncontrollable capillary oozing has occurred. The result in cases of hemorrhage following operation upon the biliary tract has been in my cases so fatal that the discovery of blood staining the dressing some days after operation cannot but cause the gravest fears. I have had four deaths from uncontrollable hemorrhage after operations upon the biliary tract. In three cases there was jaundice; in the fourth a biliary fistula had existed for a year. In the case of biliary fistula a stone impacted in the common duct diverted the entire biliary stream through the gall-bladder and out of the original wound—the wound of an operation for acute cholecystitis. There was consequently no bile

either in the intestine or in the blood. During the operation, the field, dry in the beginning, began to ooze from every capillary; and the hemorrhage could be controlled neither by ligation nor by gauze pressure. The predisposition to hemorrhage in this case could not have been owing to bile in the blood; it must have been owing to absence of bile in the processes of nutrition.

Fatal capillary hemorrhage may be regarded as avoidable in jaundiced patients only when operation is avoidable. When in jaundice life can be preserved only by the removal of the cause, usually a stone impacted in the common duct, operation must be performed, in spite of the well-known danger of hemorrhage. Under these circumstances death from hemorrhage may be regarded as an unavoidable calamity. A fatal hemorrhage in surgery, even when before operation predicted as possible; during operation observed as constitutional; after operation found to be uncontrollable; and post-mortem demonstrated to be unavoidable —a fatal hemorrhage, even under these circumstances, is the most distressing calamity of them all.

Can post-operative capillary hemorrhage in jaundiced patients be prevented by treatment before operation and the calamity thus be made avoidable?

In jaundiced patients I always use, for some time before operation, internal treatment, especially if the blood-coagulation time has not been satisfactory. The treatment consists in the use of ox-gall, fruit acids, and sometimes calcium chloride. Whether this treatment has any real preventive effect, seems extremely doubtful. When I have feared hemorrhage the most, there has been none; when I have feared it the least, it has occurred. I should still use preliminary internal medication in jaundice, however doubtful the efficacy of the treatment.

While hemorrhage has been going on, I have used in vain gelatin and calcium chloride.

In some cases of gall-bladder surgery not included in the class of unavoidable disasters, the hemorrhage has been from the friable vascular masses of malignant disease. Though these hemorrhages are perhaps unavoidable, they are to be expected; and the fatal

termination cannot be regarded as a calamity wholly to be deplored.

Hæmophilia is uncontrollable, but so unusual that I need hardly consider it in connection with this subject. I have never seen a case of hemorrhage from this cause. In one case—a case of nephrectomy for cancer in a woman—a history of hæmophilia had served to postpone operation to a time very unfavorable for permanent cure. When I first saw the patient, operation was imperative, in spite of the history. The kidney was removed without loss of blood; but the patient, herself a physician, had managed with a story of hæmophilia to postpone her operation, as it proved, beyond the possibility of permanent cure, though she lived for a year or more after the operation.

The last group to be considered includes those cases of death after operation in which no adequate cause can be found. I can offer no explanation for them.

An illustrative case recently occurred at the Massachusetts General Hospital. A woman, aged thirty-five years, was operated upon by me for an ovarian tumor. The operation was difficult and prolonged, as the tumor was deeply sessile and adherent. The patient died in three or four days with distention, obstipation, vomiting, high temperature, and high pulse. She therefore presented a typical picture of peritonitis. I had no doubt whatever that the cause of death was an extensive peritoneal infection. The autopsy showed, however, no signs of infection and no cause for death; no micro-organisms were found in the peritoneal cavity, and all cultures were sterile.

I had seen similar cases before. The only explanation which seems probable is that this was indeed a case of infection; but that the bacterium was one which escapes detection by our present methods of search; that it was one which fails to grow upon ordinary media; and that possibly the infection was one which fails to give the usual physical signs in the peritoneum. The death could not have been the result of any ordinary overwhelming infection, for there was sufficient time before death for the development of gross and microscopic evidence of a bacterial cause.

These considerations lead us, however, into realms of conjecture in which one guess is as good as another. The deplorable fact is that deaths occur in these cases. It is but a slight consolation to be told that there is no infection; for if there is no infection, how can we in future provide against the main and distressing fact—the death of the patient? Perfection of asepsis is of little moment if the patient dies.

Cases like the ones mentioned in this paper are fortunately unusual. Were they common, the surgeon's burden would be indeed too great to bear. The few cases with which I have illustrated this subject have been distributed over a period of fifteen years, and among some five thousand abdominal operations.

Can these disasters be foreseen and prevented? The answer must be, I think, in the negative. It seems unlikely that this small fraction of danger will ever be eliminated from surgical cases—the hazard of surgical operation must always include such risks as pulmonary embolism, suppression of urine, capillary hemorrhage, and inexplicable and fatal peritoneal symptoms.

DISCUSSION.

Dr. Lewis S. McMurtry, of Louisville.

There has been so much optimism in statistical discussions, especially in relation to abdominal surgery, that a large proportion of the profession, as well as the laity, have come to look upon a death after an abdominal section as being an evidence of faulty technique or lack of skill on the part of the operator, and I think this Association is greatly indebted to Dr. Richardson for presenting this subject in this way.

For one of Dr. Richardson's reputation and skill, with all of the facilities that he has in the hospitals in which he does his work, to present a study of deaths after abdominal section gives to us material of great scientific and practical value. The literature of abdominal surgery has but few contributions upon this subject.

There is one point that needs to be emphasized, and that is the statement of the essayist that he has knowledge of no death after an abdominal operation, with suppression of urine, but what it is evidence of either renal insufficiency or of renal disease. This makes it all the more important to do away with that common reason for death under these circumstances as being due to the anæsthetic. I am satisfied that the number of deaths attributed to the anæsthetic, pure and simple, is much less frequent from that cause than is generally understood, and it emphasizes the great importance so frequently disregarded in practice of making a careful examination of the urine. We all know that it is universally indicated that the urine should be carefully examined before all major operations, and yet all of us know how seldom it is thoroughly done.

Another precaution indicated by the paper for the prevention of death after abdominal operations relates to adequate time for the preparation of the patient. As a rule, the laity look upon abdominal operations as trivial. In earlier times they had to be persuaded to have operations done, but now they often must be dissuaded from operation, and the laity have come to look upon all operations in surgery as being simple and universally successful; hence, whenever an accident occurs that is distinctly unavoidable it is considered a reproach to surgery and a reflection upon the surgeon. The patient before operation is always impatient. She is a trouble to the surgeon and nurse. If sufficient time is taken for the preparation of the patient—at least three days in all operations of election—with repeated careful examination, many of the deaths that are now inevitable would be avoided. Examination of the

urine is oftentimes merely perfunctorily done by the interne or nurse; it is seldom done with the care and precision due to its importance.

Dr. Joseph Ransohoff, of Cincinnati.

There is one point in connection with the cases reported by Dr. Richardson which I would like to have elucidated by some of the members of the Association. It is the development of phlebitis following abdominal operations. It is to me one of the most inexplicable features, although the cases, as a rule, as Dr. Richardson has stated, are not grave. I have three times seen phlebitis of the left leg develop. Two of the cases were operated upon for stone in the right kidney. The operations were perfectly aseptic.

I recently had a case of suppurative appendicitis in the Good Samaritan Hospital, in which the patient was practically well; was up and about the wards until the end of the third week, when there was elevation of temperature, with phlebitis developing in the left femoral.

This explanation Dr. Richardson has given us, that, perhaps the mere recumbent position of the patient for three or four weeks is responsible for the development of this aseptic phlebitis, while it is the only explanation we have, does not seem to me satisfactory. We do not often see it in cases of stout men who are put on their backs on account of fracture of the thigh; they may have to lie on their backs five or six weeks, and yet they do not develop phlebitis. There may be something passed from the kidney into the blood in kidney operations that makes them particularly liable to be followed by phlebitis. Why phlebitis should develop on the left side when the operation is on the right, entirely away from the pelvis, is one of the things past finding out. That it may be disastrous after a seemingly trivial operation sometimes was demonstrated in the experience of a friend of mine some years ago. It was simply a radical operation for hernia. The patient was sitting up on the tenth day, ready to leave the hospital, preparations having been made for him to leave, when he fell back on his bed dead from pulmonary embolism.

Dr. Robert Abbe, of New York City.

In regard to the last point brought out by Dr. Richardson in his paper regarding phlebitis occurring on the left side, we should not lose sight of the fact that Dr. Keen in his admirable work on typhoid sequelæ called attention to this matter, saying that three-fourths of the cases of phlebitis in typhoids were in the left femoral vein, and I have demonstrated that practically to my satisfaction. In all surgical cases the anatomical relations of the right iliac artery, resting upon the left

vein as it crosses beneath it, are a sufficient cause for retarding the current in the left femoral vein, causing a slowing of the current in that vein in preference to the right. We know the risk of colonization of floating bacilli in the vein, and, therefore, with this colonization of floating bacteria and the irritation produced thereby, phlebitis on the left side is adequately accounted for. This, it seems to me, is a rational anatomical and mechanical explanation for the preference of left-sided phlebitis. As Dr. Keen has pointed out, phlebitis occurs on the left side in three-fourths of the typhoid cases where there has been no surgical interference, but in which the blood is swarming with bacteria. Why not, also, in surgical cases of any nature, where even aseptic healing of a wound does not preclude the probability that there is a slight bacterial infection in all cases ?

Dr. Herman Tuholske, of St. Louis.

I do not know, Mr. President, when I have heard a paper which has appealed to me so much because of its great timeliness and profound thought. It is one of those papers which will have a salutary influence upon those who look upon the prognosis after surgical operations of greater or less severity with great cocksureness and feel that the patients are all going to get well. Any surgeon of large experience, and particularly as large as that of the reader of the paper, must have come across cases in which the unforeseen has happened, and in which no amount of precaution, no forethought, could have avoided a fatal issue. There is no one of large experience who has not come across such cases as have been mentioned, not all of a fatal character, but coming under that head are those cases of thrombosis of the veins with which I am unfortunately rather familiar. It is difficult to explain the frequency of phlebitis of the large veins of the thigh and pelvis after operations that run a perfectly aseptic course. Nor is the occurrence of phlebitis on the left side after perfectly aseptic appendectomies so very rare, for in the experience I have had, and in the cases that have run an aseptic course with satisfactory termination, there was thrombosis on the left side that produced for months afterward œdema of the limb and to a certain extent limitation of function for a long time. I have especially noticed, after abdominal operations for the removal of large fibroids in women, that quite a considerable amount of heart-muscle degeneration had occurred, perhaps not palpable or readily detected by the ear, but in whom there was nevertheless that peculiar weakness of the circulation due to the presence of the fibroid or fibroids for a long time. These cases were all of a septic character. I have had eight cases in the last five years in which, after they had nearly recovered so far as I could see,

phlebitis occurred on the left side, with a great deal of disturbance which kept me anxious about them for weeks, and I felt that there was probably some secondary infection which was the cause of the thrombosis. In some cases I expected a light thrombosis or embolic trouble after operation, but it did not materialize.

I was glad to hear Dr. Richardson's explanation of phlebitis occurring in these cases, and I have no doubt there is a great deal in it, but the subject needs considerably more illumination. I believe position has a great deal to do with it. In the weak and poorly fed a certain position may be used by the patient to relieve abdominal tenderness or to get comfort, and marantic thrombosis may occur. Drawing up the limb, keeping it up possibly, or a bandage over the abdomen and spica over the thigh may have something to do with the development of phlebitis. But I am not sure it is the sole cause, for the reason that phlebitis rarely occurs from the position assumed by a patient with fracture of the thigh, or from position alone; but marantic thrombus, position, and anatomical peculiarities in each individual case should be considered as factors in the development of the complications that have been mentioned.

With regard to some of the other points mentioned in Dr. Richardson's paper, I remember very well that on one occasion, after an operation for gall-bladder disease in which there had been profound icterus, the patient died from oozing, although calcium chloride was used for a considerable time.

Under one of the headings of Dr. Richardson's paper I wish to report a fatal case of foudroyant sepsis. Here was a patient in whose case we used every possible precaution, with no discoverable hemorrhage, yet she was utterly overwhelmed with sepsis and died. We opened the abdomen, but a careful search showed no gross pathological condition. The patient died before the challenge could be taken up by the peritoneum. There was no local manifestation. Bacteriological examination was negative. I cannot say, however, in this case that the examination was of that searching character which would make me absolutely certain that the trouble was not septic; still I felt it was one of those overwhelming, unforeseen, and inevitable calamities which came upon me. The same thing I had occur in a case of uræmia, with suppression of urine, in which the examination was careful and thorough. There was no indication of renal disease. She did fairly well for the first day or two, when urinary secretion was arrested, and in spite of everything we did to reproduce it she died four days after the operation. Possibly there is in each case something we cannot gauge. Not all patients are alike under the knife. Some of them will die, and we cannot gauge the

cause. We know there is a peculiar nerve element in some of them which is not present in others. All patients cannot stand an anæsthetic; all patients cannot stand an operative procedure. But I believe if the cases are studied more closely and carefully with reference to their peculiarities, fewer of these calamities would occur, and every possible precaution should be taken to prevent them.

I am glad this paper has been read, so that the impression may grow among the laity that rational, skilful surgical operations may legitimately prove fatal.

Dr. Leonard Freeman, of Denver, Colorado.

I think the statement made by the two previous speakers that thrombosis of the femoral vein does not occur in simple fractures should be corrected. In my own limited experience I have encountered three such cases, and I have no doubt others have made similar observations. Two were cases of fracture of the tibia on the *right* side; the third, one of fracture of the patella on the right side. Thrombosis occurred in each case in the *left* femoral vein two or three weeks after the fractures. I shall not attempt to give an explanation.

Dr. Charles B. Nancrede, of Ann Arbor, Mich.

I desire to put on record two cases that fortunately terminated differently from those reported by the reader of the paper.

In one case the patient was a man upon whom I operated this past winter. He was badly jaundiced, and after the operation he bled and bled, more or less, for eighteen days; but after large doses of calcium chloride, which had been employed for some time previous to the operation, and gelatin injections, he made a good recovery.

The other patient was a woman whom I treated in the same way. She bled to an alarming extent for a number of days after operation; but the hemorrhage gradually ceased, and she recovered so far as it was concerned. I do not know whether the injection of a sterilized solution of gelatin in normal salt solution into the wound had any effect in saving the last two patients or not, but certainly after injection in both cases the hemorrhage began to stop.

I recall another case that bled to death; nothing I did would stop the hemorrhage. With the exception of the last case, the others were treated with calcium chloride both before and after operation.

Dr. William J. Mayo, of Rochester, Minn.

Just one word in regard to the frequency of phlebitis. We have found that nearly 2 per cent. of our abdominal operations are followed by phlebitis, usually on the left side. In many of the cases the phlebitis

is so slight that it is scarcely noticeable. One per cent. will have nothing more than an enlargement of the vein, attended with pain, perhaps, and followed by œdema. There are some cases in which there is only a little pain in the calf of the leg, with a small amount of swelling. These cases leave the hospital at the end of two or three weeks, although a little lameness is experienced in walking. I have seen phlebitis of the left side follow a gall-bladder operation. I have seen two cases apparently of pulmonary embolism that have recovered. One came on the fifth and the other on the ninth day. Both were followed by phlebitis on both sides, coming on about the fourteenth day. Our observation has been that those cases of pulmonary embolism, in which the patient has seemingly a good heart (shown by a regular steady pulse), which continues to force blood against the pulmonary obstruction, will practically all die. Only those cases in which the pulse becomes exceedingly feeble and rapid, running up to 180 or 200, may recover, because the lungs are given a little chance to compensate. In the two cases I mentioned as having recovered, they had this exceedingly rapid heart action, and for several days they were in a condition in which it seemed as though they were going to die, but they slowly recovered, and the peculiar feature in connection with both cases was the development of phlebitis on both sides at the usual time.

Dr. John Collins Warren, of Boston.

I should like to say a word or two about the origin of thrombi, and to put on record my opinion that these thrombi are not always septic. They are marantic as well as septic. In some experiments on the ductus arteriosus, as well as from some observations made on the newborn child, I have found well-developed thrombi, showing that a thrombus may be physiological in certain cases, and not septic. Therefore, we ought not to feel so positive as many surgeons do that thrombi are necessarily of septic origin.

Dr. Richardson. I have nothing in particular to say, except that I have been very much interested in the discussion. I have been disappointed that no one has told me how to avoid these complications. It seems quite possible in some cases to account for phlebitis in the lower extremities by the enforced quiet imposed upon the patient. This, with the retarded return of blood on the left side, owing to anatomical peculiarities of that side, has seemed a possible if not a probable cause of phlebitis on that side.

Dr. Warren's well-known opinion, expressed in his work on the healing of arteries based upon the closure of the *ductus arteriosus*, encourages

the view that thrombi are not always septic. It is hard to believe, from clinical observation, that the process, in the great majority of cases, has a bacterial origin, or that the existence of phlebitis is in itself a proof of the failure of aseptic methods.

The complications mentioned in my paper are, in most instances, unavoidable, though it is a bold statement that nothing is possible in the future development of surgery and medicine.

With regard to hemorrhage, my experience has been that when, after gall-bladder operations, especially in jaundiced patients, blood begins to ooze from the wound, a fatal termination is most probable. This is not, however, an invariable rule.

AN INTERDENTAL ADJUSTABLE METALLIC SPLINT FOR THE TREATMENT OF FRACTURE OF THE LOWER JAW:

WITH REPORT OF CASES IN WHICH IT HAS BEEN APPLIED BY THE AUTHOR.

RUDOLPH MATAS, M.D.,
NEW ORLEANS, LA.

THE ideals aimed at in the treatment of fracture of the lower jaw are: 1. To reduce the fracture accurately. 2. To maintain reduction and immobilization of the fragments until firm union is obtained. 3. To provide for the hygiene of the mouth, which suffers constantly from salivary stagnation and putrid decomposition. 4. To meet the preceding indications with the least interference with the oral and maxillary functions (feeding and speech).

To satisfy all these desiderata fully and without some sacrifice of the last two conditions is evidently impossible in *all* cases, and the manner in which these indications can be met will depend upon various circumstances, among which the most important are the extent and situation of the fracture, which are alone sufficient to determine whether the fracture can be successfully treated by *partial* or *total* immobilization of the jaw. It is evident that if the functions of the temporomaxillary joint are not interfered with and that the fracture line can be kept at rest during repair, thus permitting the patient to open and shut his mouth at will, the cleanliness of the mouth and oral functions (feeding and speech) will be maintained with a minimum of discomfort to the patient.

One of the most notable advances in the treatment of fractures is the tendency to diminish, as much as possible, the period of func-

tional disability during the process of repair. The aim of the surgeon is to secure the conditions necessary for perfect osseous union with the least interference with function. This is well exemplified in the ambulant treatment of fracture of the lower extremity, which provides for the conditions necessary for perfect bone union without seriously restricting locomotion. If this is true of fractures of the extremities, how much more important and desirable it must be to preserve the functions of the jaw during the process of repair when this bone is fractured! The serious consequences of the functional disability of the lower jaw, caused by fracture, are manifested, not only by interference with the speech and feeding of the patient, but more particularly by the disastrous effects of salivary putrefaction and oral sepsis, which have given this fracture a special interest to the surgeons of all times. Apart from this, the actual technical difficulties encountered in maintaining the apposition of the broken fragments during repair are, in many cases, very great, and account for the vast amount of mechanical ingenuity and thought which has been expended on the subject by succeeding generations of medical men, from the days of Hippocrates and Celsus to the present time. That the problems involved are real and have challenged the ingenuity of the best minds of the profession is best told by the bibliography of the subject. A hasty glance at the *Index Catalogue of the Surgeon-General's Library*, including the second series, vol. viii., 1903, shows references to over 250 articles on the fracture of the lower jaw. By consulting these references and other sources of information, we have collected the descriptions of over seventy-five different appliances, devices, and methods of treating this special fracture. This list, which is very incomplete, is made up largely of the contributions of the surgical writers of the eighteenth and the first half of the nineteenth centuries. The bibliography of this fracture is a monumental repository of the progress of surgery, in which are found, almost in chronological order, the illustrious names in surgery of all the ages. In looking over the list of appliances and references to the methods of treatment which have been employed in the past, we are struck by the fact that almost every one of the mechanical devices and

methods of treatment at present in use, and regarded as new by our contemporaries, find their prototypes in ancient publications and have been known and applied, at least in principle, by old and forgotten authors. Apparently the present generation has only succeeded in resurrecting old principles and applying them again in a modernized garb. Real progress has undoubtedly been accomplished by adapting to the fundamentally correct ideas of the older authors the improved technique of dental mechanics and prosthetics, by using better material and appliances for taking impressions of the jaws, thus improving the quality of the interdental splints which are still necessary in some cases; but, apart from this, we fail to find anything essentially new in our modern armament.[1] To the student of this subject and to the experienced surgeon, it is evident that, notwithstanding the multitude of resources and abundance of appliances, no single method or device will avail for all cases, and that a certain eclecticism and judicious selection of methods must be exercised in order to obtain the best results in individual cases. No one will deny that the most perfect results would be obtained in all cases by the collaboration with the surgeon of a dentist skilled in the methods of oral prosthetics and dental mechanics; but as this is practically impossible in the urgent conditions in which these patients present themselves to the surgeon for treatment, it is proper that the simplest methods available to the general surgeon, with the material at hand, should be utilized, at least in the first or provisional dressings. Fortunately, a great many of these fractures are simple, and the tendency to the displacement of the fragments is so slight that recovery has been known to take place without any sort of treatment whatever. Boyer reported a case of a water-carrier, who refused to be treated with any restricting bandage and recovered with very slight deformity, notwithstanding that he used his jaws in chewing, eating, and drinking as usual; and, also, another curious case is reported

[1] In further confirmation of this statement, see the erudite monograph by Béranger Feraud (L. J. B.): Traité de l'immobilization directe des fragments osseux dans les fractures, Paris, 1870, and the encyclopedic article by F. Guyon, entitled "Maxillaire (os) Pathologie," in the Dictionnaire de chambre, tome 5 me. deuxième série, 1872.

by A. Bérard, that of a child whose fractured jaw would not unite until all the immobilizing appliances had been removed, when union quickly took place (Guyon). Of course, these are exceptional cases, which, by their very rarity, emphasize the rule.

In the Charity Hospital of New Orleans, where twelve or thirteen cases are treated annually (in the last twenty months, up to October 1st, twenty-five cases of fractured lower jaw were admitted), a large proportion of these patients are treated in the clinics by immobilization with a chin-piece of moulded material and a Barton bandage; fully ten out of twenty-five cases were treated exclusively by this method, and apparently with fairly good functional results. In these cases, in which the lesions of the mucosa and the soft parts are comparatively insignificant and the tendency to displacement is slight, the patients, who are usually of the laboring class, suffer comparatively little pain and stand the privation from solid food with comparative resignation and cheerfulness. In this class of patients the immobilization of the jaw by chin splint and a sling or head bandage is not absolute, and soon allows of a certain amount of separation of the jaws, which favors the cleansing of the mouth by irrigation with antiseptic solutions and permits comparatively easy alimentation with liquid and soft foods.

On the other hand, there are many cases of single and multiple fracture in which the tendency to recurrent displacement after reduction is most obstinate; in these cases the damage to the buccal mucosa is considerable and the tendency to buccal sepsis and submucous infection is great. It is in this class of fractures that the most perfect coaptation is desirable, with the greatest freedom of access to the interior of the mouth for purposes of disinfection. These are the patients who have furnished the material for the greatest number of inventions, and, even now, offer problems which tax the originality and resources of the practical surgeon and the dental specialist. Judging by the current literature, they are still fruitful material for discussions in journals and societies.[1] It

[1] In the Index Medicus will be found references to fifteen separate articles on fractured lower jaws which have appeared in journals and society transactions from January to September, 1904.

is fortunate that the majority of these fractures occur in the mandibular arch, in front of the angles and within the line of the teeth, and that it is possible in many of these to immobilize the fragments without interfering with the movements of the temporomaxillary joint.

In fractures of this class, if the teeth are strong and firmly implanted, the broken fragments may be held in place by the old Celsian plan of wiring the adjoining teeth, using them as binding posts. This method, which has been perfected and modernized by Angle and Löhers, who use clamps and bars to lock the teeth together, is only rarely applicable because the teeth are either loosened by the injury or subsequently mobilized by the strong traction of the jaws and muscles at the line of fracture. To obviate this difficulty, the peridental wire splints of Hammond, Sauer, and Martin, and the fracture clamp of Shotwell have been devised and applied with success by their advocates; but, as they require special skill in their application and they also offer comparatively little resistance to muscular traction, are only applicable in certain favorable cases. Far more accurate and reliable are the moulded dental splints which fit over the crowns of the teeth following the contour of the dental arch; they are made of metal, hard rubber, or vulcanite, cast on moulds of the teeth out of plaster-of-Paris impressions. These dental splints were originally suggested long ago by Fouchard, Prestat, Malgaigne, Morel-Lavallée, and have been modernized and perfected by Kingsley, and before him by Gunning, Hayward, Bean, Moore, Lonsdale, Hill, in this country and England; by Martin in France; by Weber, Suersen, Haun, Anton Witzel, and quite recently by Warnekros and Kersting in Germany; but all these, while admirably meeting the conditions in the hands of their inventors, have a disadvantage that they require the assistance of specialists in dental mechanics, whose services are not always available at the time when these cases are brought to the surgeon for treatment; and even when the specialist is available, they often require much time and many trials for their preparation and application. Nevertheless, there are many cases in which splints made from casts are required in order to make them fit

accurately over the dental arch. This is particularly true of those cases in which the contour of the dental arch is made very irregular by the loss of several teeth at different points, or in those cases of partial fracture of the jaw in which a large section of the alveolar process is broken, carrying with it a number of teeth which wobble constantly with the fragment of bone to which they are attached.

We purposely exclude from consideration in this connection the comparatively rare fractures of the rami, of the condyloid, and of the coronoid processes in which no interdental immobilizing appliances, as a rule, are applicable, and in which the suppression of all jaw motion is absolutely mandatory as an essential to repair. Neither shall we consider those extreme cases of multiple comminuted fractures of the jaw which result from gunshot and railroad injuries and other forms of violence in which the number and mobility of the osseous fragments, together with the enormous damage done to the soft parts, precludes all possibility of applying any device which requires some fixed point of support for its successful application. In such instances, the question of immobilization and osseous repair is secondary to the more vital and pressing demands of drainage and asepsis; the correction of deformity and impairment of function being relegated to a secondary plane in meeting graver complications.

Therefore, if we leave out of consideration the two extreme groups of jaw fractures—*i. e.*, the very simple, with little tendency to displacement, on the one hand, and the very serious, compound, multiple, and complicated cases, on the other, in which no sort of restraining appliance is available to prevent deformity, etc.—there is still the middle class, previously referred to, which it would appear desirable and advantageous to treat by some ready method which would satisfactorily meet the requirements of asepsis and repair with the least discomfort to the patient.

The presence of a considerable number of these troublesome fractures in a large hospital service has, for many years, impressed me with this need. I have felt the want of an appliance which could be adapted to the conditions which we find in a great number,

if not the majority of these patients, and which could be readily and successfully adjusted by any medical man with ordinary surgical training, without the need of calling upon a specialist in dental or oral mechanics for its application.

While the idea of a universal splint for fractures of the lower jaw that will fit all patients is, of course, absurd, it is not unreasonable to hope that a comparatively simple contrivance can be devised which will be serviceable in a large number of the more common types of this injury, as they present themselves in our clinics. Reasoning on the data of experience, which show that this fracture occurs chiefly in men (90 per cent.); that it occurs in the adult (dentulous) period of life, from the twentieth to the fiftieth year (in the last twenty-five cases of this fracture attended in the emergency service of the Charity Hospital of New Orleans, the average age of the patient was twenty-three years), and that fully 90 per cent. of these fractures occur in some part of the anterior or projecting segment of the maxilla in front of and including the angles, it is not a vain hope that by a proper selection of material a splint may be devised which will permit of adaptation to a large number of these patients.

That the same need has been felt by others is very apparent in the writings of the older surgeons of the past century. Bush (1822), Houzelot (1826), Joussett (1833), Malgaigne (1847), Morel-Lavallée (second appliance) (1853), Rütnick, Kluge, and others too numerous to mention, thought of appliances which acted more or less on the same principle—*i. e.*, that of a clamp which held the broken fragments of the jaw in the grip of a plate which fitted over the teeth, and an extrabuccal piece, which was adjusted over the chin. A great variety of models were thus designed, made of various materials; some of them very ingenious and no doubt useful in the special cases in which they were applied; but they all appear to have failed in some essential which was necessary for general utility, as is shown by the fact that they have never retained a permanent place in the armamentarium. The chief defects that can now be recognized in these older splints is in the use of material in the dental plates which lacked adaptability to the numerous

variations and conditions of the dental arch which are met in fractures.

In later days this objection has been overcome, as far as individual cases are concerned, by the use of moulded hard rubber or metallic splints, which are moulded or cast over plaster impressions of the dental arch of the particular patient for whom they are intended. These dental splints may be quite sufficient in themselves, as stated previously in this communication, to hold the broken fragments in position, or they are attached to outside bars or braces, which project from the mouth and hold the dental plate firmly to an adjustable chin-piece. In this way the primitive and crude models of Rütnick, Morel-Lavallée, and others have been modernized through the efforts of the dentists of the present day, notably by Kingsley and a host of others in this country; by Martin, of Lyons; by Lohman and A. Witzel, and others in Germany. The objection to these, however, from the point of view of the surgeon who has to deal most often with these fractures in large surgical clinics, is that they fail to meet the requirements of emergency and charity practice. These patients, as a rule, apply first to the general surgeon, whose duty it is to meet the indications as thoroughly as possible. If the patient is to be transferred to the care of a dental specialist, days must pass before a perfectly fitting splint can be attached; in the mean time, if the displacement is not properly corrected, the patient suffers great hardship.

As far back as 1897 I had occasion to exhibit to the Orleans Parish Medical Society (*vide Transactions* of this Society for 1897) a modification of a metallic splint devised with the objects previously stated in view, by Dr. Robert C. Ackland, of St. Bartholomew's Hospital, London, and described by him in the *British Medical Journal* of April 1, 1893. At that time the splint appeared to meet the conditions of the average adult case of fracture of the jaw, theoretically, quite well; but, with increasing experience, I had to abandon it, because the dental mouth-piece, which fits over the arch of the teeth, was not flexible enough to permit its adjustment to the numerous variations of the arch that are met in practice;

neither was the chin-plate adjustable to the various degrees of prognathism; moreover, the projecting twin bars which connect the dental plate with the chin-piece not only interfered with the sphincter functions of the mouth, permitting the escape of fluids and dribbling of saliva, but they caused deep ulceration at the angles of the mouth, and so much distress to the patient that it had to be abandoned. For a while we tried other methods and also resorted to the suture of fragments in the multiple compound and more difficult cases, but the results have not justified the general adoption of this method, except in a few selected cases. The admission last winter of a number of fractures of the lower jaw in our clinics, in which the tendency to displacement was very marked, led us again to experiment with a new metallic splint. While this splint is not in the least new in principle, it is original in its construction and in the combination of different suggestions from various sources which we have found of value in overcoming the practical difficulties which we have encountered.

[The description that follows applies to the latest improved model, which we have tried only in one case. The first five cases reported at the end of this paper were treated with the first two models, in which the dental piece or gutter was permanently fixed to the clamp and was not provided with the Wiley cuts, which make the present dental splints so much easier of adjustment to different jaws.]

The splint is constructed on the principle of a clamp, which holds the entire projecting arch of the jaw (from the chin to the angles) firmly in the grip of a flexible mouth-piece, which fits like a gutter over the entire dental arch, and, of an external plate or chin-cup, which extends from the symphysis to the angle. The mouth-piece and chin-plate are both detachable; the chin-cup is made adjustable to various degrees of prognathism by a sliding joint fixed by a pin and thumb-screw. The appliance, therefore, consists of three component parts, the details of which are as follows:

1. The *mouth-piece* or *dental splint proper*. This is horse-shoe in shape, and in the latest model is made after the pattern of

the impression trays used by dentists to take casts of the lower dental arch. It is hollowed in three planes to fit loosely over the crowns of the teeth, the groove or gutter broadening from before backward to correspond with the increasing diameters of the molars. The edges of the splint form two flanges or rims which project downward; the outer flange extending to the neck of the teeth on the outer or buccal side, the inner flange or rim dipping to a lower level, almost touching the gums on the inner or lingual side. This dental piece is made of block tin and is indented approximately on a level with the bicuspids by two deep cuts which penetrate the gutter to its outer rim, leaving a narrow wedge-like space, which is closed at the apex by the outer or labial rim of the splint. These cuts were originally suggested by Dr. J. K. Wiley to increase the flexibility of the dental impression trays in making impressions of the lower jaw. The softness and flexibility of the metal of which the splint is made, together with the Wiley cuts, allow the operator to adjust the splint to the varying contour of the lower dental arch as it is met in different individuals.

After studying the dental arches and maxillary contour of fifty different persons of both sexes and various ages, from the fifth to the sixtieth year, I had the splint made in three different sizes: the smallest for children, the medium size for youths and young women, and the largest size for full-grown adults. From these different sizes a selection can be made to fit the jaw of almost any normal individual who is likely to suffer from this injury.

In addition to the ease with which the splint can be moulded to the outline of the dental arch, the breadth of the gutter can be increased and otherwise altered by stretching the flanges and modelling them with a pair of ordinary hand pincers. The dental gutter is also provided with a deep groove or slot in the centre of its inner or labial surface, which fits the hook at the tip of the clamp and holds it very firmly in position when it is locked. By this arrangement the splint is easily attached to the clamp after it has been adjusted to the jaw.

2. The *chin-piece* is made of perforated aluminum and is shaped to fit the contour of the jaw. It can be moved backward and for-

ward on a sliding joint, which is adjusted by a thumb-screw and is attached to the lower limb of the clamp. In order to prevent injurious pressure on the skin of the chin, it is padded with cotton wadding, covered with a layer of gauze, smeared with oxide of zinc ointment.

3. The *clamp* which holds the mouth and chin-pieces together is made of soft steel and consists of an upper and lower limb screwed together at a considerable distance in front of the mouth. The upper limb projects from the middle of the mouth and is curved over the lower lip so as to allow the mouth to be closed; a very necessary provision to prevent salivary dribbling and to permit a complete control of the mouth in drinking and eating. The pressure required to hold the jaw firmly in the grasp of the intra-buccal and extra-buccal pieces is obtained by a screw attached by a swivel joint to the upper limb of the clamp, the pressure being regulated by a thumb-screw, which acts on the lower limb of the appliance. (See Fig. 1.)

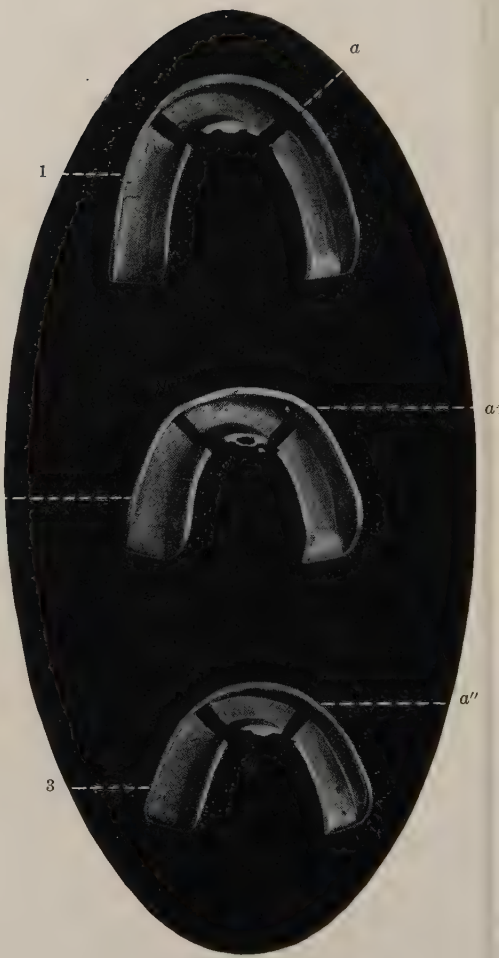
Application of the Splint. The chief object of this splint is to immobilize the broken fragments of the jaw without restricting its movements as a whole, thus permitting the mouth to be opened and closed at will. It is especially intended for compound fractures of the maxillary arch (symphysis and body), whether single or multiple, in which there is a marked tendency to recurrent displacement and that require frequent inspection and antiseptic irrigation of the oral cavity. It is obvious that in fractures involving the angles and rami of the jaw or the condyloid and coronoid processes, or in the graver cases of gunshot and other injuries in which there is great comminution of the jaws with laceration of the soft parts, that total immobilization of the maxilla is necessary and that the splint as a clamp cannot be used. In some of the cases the dental gutter or mouth-piece may be applied with a chin bandage after the reduction of the fracture. This part of the appliance is then used solely as an interdental splint and as an adjunct to the moulded chin splint used in such cases and held in place with liquid glass, starch, or plaster-of-Paris bandage. The best chin splint in such cases is a piece of porous blanket or coarse flannel,

FIG. 1.

Author's adjustable metallic splint for fracture of the lower jaw (latest model). The splint consists of the following detachable parts: (*a*) a mouth-piece of soft metal (block tin); (*b*) a clamp adjusted and tightened with a screw; (*c*) a chin plate (of perforated aluminum), which can be moved backward or forward by sliding on the lower limb of the clamp. This is fixed and held in place by a thumb-screw.

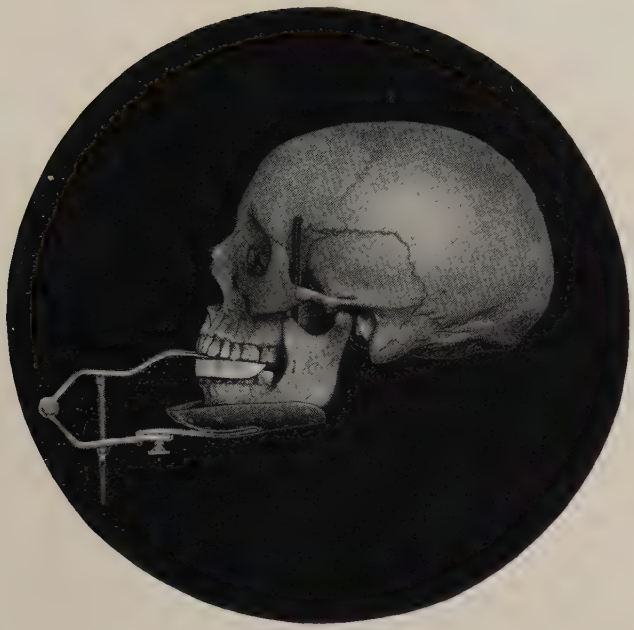
Fig. 2.

Fig. 3.



Superior and inferior views of three detachable and interchangeable mouth-pieces, or dental plates, which are supplied with each splint. No. 1, *large size*, for adults; No. 2, *medium size*, for youths; No. 3, *small size*, for children. In addition to the softness of the metal used (block tin), which allows each mouth-piece to be adjusted to the contour of the jaw and teeth, the adjustment and adaptation of these splints to individual cases is further obtained by cutting partial sections (*a a' a''*) in each mouth-piece, as suggested by Dr. G. K. Wiley, in the manufacture of the adjustable impression trays used in dental practice. The hollow groove in each mouth-piece can be filled with the soft moulding compound, or dental wax, used in dental practice. In this way loose teeth are held in place, the mobility of the splint is reduced to a minimum, and the difficulty of obtaining a uniform compression caused by the vertical irregularities of the teeth is overcome.

Fig. 4.



Lateral view of the splint *in situ* as shown on adult skull.

Fig. 5.

Front view.

Fig. 6.

Interior view, showing the adaptation of the hollow dental plate to the contour of the teeth on their lingual aspect. All these illustrations show the clamp-like action by which the splint holds the maxilla, and its mode of action in all fractures of the symphysis and body as far back as the angle of the jaw.

thoroughly soaked in plaster cream. This is readily moulded to the contour of the chin and jaw and allowed to dry *in situ*, any excess of the cloth being trimmed off while the plaster is setting. It is understood that the skin must be thoroughly shaved and lubricated with vaselin before applying the plaster.

If we take, as an example, a typical case in which the jaw is broken obliquely through the body, the first step is to shave the skin and disinfect it in the usual manner. If there are wounds which require suture, they should be closed, preferably with aseptic zinc oxide adhesive plaster strips, which secure the closest coaptation without the risk of stitch abscesses. A general anæsthetic may or may not be required, according to the peculiarities of the case. The mouth should be thoroughly disinfected as carefully as possible by copious irrigation with a hot lysol solution (2 per cent.). After reducing the fracture, the contour of the dental arch should be restored, and while the bone is held in place by combined external and internal manipulation, one of the metallic dental gutters is selected, according to the age of the patient and size of the jaw and fitted on the arch of the teeth. Usually the splint requires some moulding with the fingers before a fairly accurate fit can be obtained. If the splint fits well, it will usually hold the fragments in apposition by pressing it firmly against the teeth while making downward and forward traction toward the chin. In many cases in which the teeth are loose or missing in places, it will be necessary to fill the gutter of the tray with a modelling composition or wax used by dentists in making impressions of the teeth. I have found the "Excel" modelling compound, sold in all dental depots, especially useful for this purpose; it is quickly softened by dipping in hot water and can be spread very easily over the inner surface of the tray. While the modelling compound is still soft in the gutter splint, this is applied to the dental arch and allowed to remain *in situ* until it becomes hard by cooling. In this way the loose teeth are held in position, the gaps between them are filled up, and the splint is fixed in place. The outside clamp is now adjusted. Special care must be observed in protecting the skin of the chin, which is frequently contused and liable to

inflammatory œdema. This is best done by thoroughly padding the chin-plate with cotton wadding and gauze, smoothed over with zinc ointment. After the chin-plate is adjusted, the clamp is tightened with a screw with sufficient firmness to hold the mouth-piece in place. The patient is taught how to irrigate his mouth with a fountain syringe, the irrigations to be thorough and frequent; every hour or two during the day is not too often. In cases in which there is marked contusion of the soft parts and tendency to swelling, it is necessary to relax the tension of the screw at frequent intervals to prevent blistering and pressure necrosis of the skin of the chin. In these cases it is necessary to immobilize the jaws during the first few days until the swelling has subsided, using for this purpose a Barton, Gibson, or a sling bandage, which will reinforce the splint and keep it in position while the tension of the clamp is relaxed. After the swelling has subsided, the outside bandages are removed and the splint alone is used, allowing the patient to open his mouth freely for all purposes. Even then, however, it is important that the tension of the clamp be relaxed at various intervals, according to the tolerance of the patient; so necessary it is to protect the skin of the chin from the effects of undue pressure.[1]

Clinical Reports of Cases to Illustrate the Use of Author's Splint.[2]

Case I. *Double compound fracture; one through the left body; the other through the right angle of the lower jaw.*—A. S., a German

[1] In closing this paper, I desire to thank my assistants and friends, Dr. H. H. Rightor (now of Helena, Ark.), to whom I am especially indebted for valuable suggestions and diligent observations in the first five cases in which the splint was used; to Dr. U. Maes for valuable assistance in making the last model; and to Mr. W. E. Sistrunk, resident interne, Charity Hospital, for clinical observations and statistical data. Also to the McDermott Surgical Instrument Co., of this city, who now manufacture the splint and supply it to the trade, for their valuable co-operation.

[2] The first four observations are abstracted from the original histories written by Dr. H. H. Rightor (Tulane Class, 1904), who embodied them in his graduation thesis, entitled, "A New Splint for Fracture of the Lower Jaw, with Reports of Cases."

lad, aged eighteen years. On December 19, 1903, while under the influence of whiskey, he attempted to alight from a moving street car and was struck full in the face by a small tree. An ambulance was at once called for and he was carried to the hospital, reaching there about 6 P.M. He was unconscious when first seen by the ambulance surgeons, but soon recovered. His whole face was horribly contused, looking like a mass of jelly, but the only bone injury was a double compound fracture of the lower maxilla; one being an oblique fracture through the angle on the right; the other through the body, between the lateral incisor and the canine tooth on the left. There was no great deformity at the interdental fracture, the right fragment being slightly anterior to the left; at the angle, however, the anterior fragment was displaced under the posterior for one-half inch. A cardboard chin-piece was moulded to the jaw and Barton's bandage was applied over it. This in nowise approximated the ends of the bone and seemed to increase the pain. He suffered intensely all night, requiring morphine hypodermically. The following morning the bandages were removed and the mouth thoroughly irrigated. The splint designed by Dr. Matas was applied. After reducing the fracture it held the bones in perfect apposition. Though the angular fracture was behind the line of the teeth, the patient was able to use his jaws without discomfort. Nevertheless, since his two upper central incisors were missing and there would be no difficulty in feeding him, it was deemed more prudent to apply a bandage in order to immobilize the jaws. In attempting to nourish him by means of a rubber tube with a funnel attached, it was found that the upper bar of the clamp pressed on the lower lip, preventing the perfect closure of the mouth, thereby rendering sucking impossible and allowing dribbling of saliva. Another splint was made with an upward curve over the lower lip, which permitted the mouth to close perfectly. The after-treatment was simplicity itself. The patient irrigated his own mouth every two hours with a gallon of 0.5 per cent. lysol solution, keeping it sweet and clean. The diet was limited to liquids for a few days, and then, when the outside bandage was removed, a more liberal dietary was allowed. Every

fourth day the clamp was loosened and the chin was wiped with alcohol. His recovery was uneventful. On the twenty-first day the splint was taken off and the result found to be perfect. There was no deformity and the teeth articulated well. The lower set was somewhat blackened from the long contact with the metal, but a few brushings with a tooth powder was all that was needed to restore the original color and polish.

CASE II. *Single compound oblique fracture involving angle of the jaw.*—J. H., muscular white man; aged twenty years. On Monday, January 9, 1904, he became intoxicated, and when on his way home got into an altercation with two grown negro men. They finally came to blows, one of them striking squarely on his left jaw with his bare fist. The blow knocked the patient down; he was unconscious for a short time, during which his opponents fled. He soon recovered and walked to a neighboring drug store, suffering no great pain, except when attempting to speak. The deformity was so marked that a diagnosis of fracture of the jaw was made on inspection. The examination showed that the line of the fracture was an oblique one, bisecting the angle of the jaw; the anterior fragment was displaced behind and below the ramus. It was impossible for him to close his mouth; crepitus abnormal mobility, etc., in fact, all the classical signs of fracture were present. Digital examination of the mouth showed that the line of fracture terminated just behind the last molar tooth on the left side. The mucous membrane was torn for over an inch. The assistant house surgeon, who attended him, met with no difficulty in accurately reducing the fracture, but found that it was impossible to maintain reduction by the usual routine method. The last splint devised by Dr. Matas and used on the preceding case was readily introduced and over this a modified Barton's bandage applied. There was now no tendency to recurrence; the pain was immediately relieved, and he never suffered after. The subsequent treatment was the same as in Case I. This patient had also a missing tooth and through this space he was nourished and the oral cavity irrigated.

The splint was removed on the eighteenth day, and, with the

exception of a small amount of callus on the outer surface of the bone, no trace of injury remained.

CASE III. *Compound fracture of the body of the jaw between canine and incisor teeth.*—E. B., white male, aged twenty-three years. On January 13, 1904, while he and a crowd of companions were drinking, he got into a fight with his brother-in-law. According to the patient's story, he had the best of it, his opponent being on the ground and he on top of him. While they were in this position, a brother of the opponent struck the patient full across the right face with a club, "knocking him senseless." He remained unconscious during the night, bleeding from the jaw all the time. The following day he was taken to the station and brought by train to New Orleans, thence to the Charity Hospital, arriving there twenty-six hours after the injury. He was very weak and pale from loss of blood. It was determined that he had a fracture of the lower jaw, compound externally and internally. The line of the fracture being between the left lateral incisor and the canine tooth, extending the whole depth of the jaw. There was a tendency to displacement on motion. The mouth was thoroughly irrigated; the face shaved, the external wound dressed. The splint first used on Case I. was applied, as the improved one was still in the mouth of Case II. Fortunately, the man had extra long teeth, and the curve on the upper limb of the clamp was not necessary, and he was able to close his lips perfectly. No bandages were necessary in this case, excepting a small piece of adhesive plaster, to hold the dressings on the external wounds. He was able to open and close his mouth from this on without pain. Irrigation was practised, as in the other case. In a few days the mucous membrane had healed, and he was allowed soft foods. Mastication caused no disturbance of the fragments. About the time that the splint should have been permanently removed—the eighteenth day—the interne assigned to the service was taken sick, and, as the patient was loitering around, caring for himself, he was in some way overlooked, and allowed to use the splint twenty-eight days. At the end of that time it was removed. The union was firm and without appreciable callus. There was, however, a pressure ulcer, the size of a twenty-five-cent piece, under

the symphysis due to insufficient padding of the chin-piece and neglect of the skin. This healed readily under treatment.

Case IV. *Compound double fracture, involving the body of the lower jaw, between the centre and lateral incisor and through the body obliquely into the angle on the same side complicated with fracture of the right upper jaw opening into the antrum; also fractured zygoma and contusion of the brain.*—No history could be obtained of this case, except that the patient, who was a colored man, aged twenty-three years, had been the victim of a railroad accident. He was admitted on March 12, 1904, four days after the injury. When admitted he was delirious and in a profound septic condition. The features were unrecognizable on account of the great swelling, and the mouth emitted a horribly foul and unbearable odor. After recognizing the fractures of the jaw (lower), the splint used in Case II. was applied, and held the ends of the bones in perfect apposition. As there was no tendency for displacement, no bandages were applied. Copious irrigations were practised hourly to disinfect the mouth, which could be opened with comparative ease, on account of the fixation obtained by the splint. In this way the local condition of the mouth was very much improved. The patient died on the fourth day after admission from the effects of the contusion and sepsis. The autopsy confirmed the clinical diagnosis. This case is quoted simply to show that the fractured jaw was well controlled by the splint and permitted free and copious irrigation of the mouth while the fragments were held in apposition.

Case V. *Alveolar fracture involving the bicuspid teeth on the left; complete fracture through the body obliquely to the angle on the right.*—Miss N. F., aged twenty years, on June 28, 1904, was assaulted by an unknown negro, who struck her a terrific blow on the face with his fist. She was stunned without becoming wholly unconscious. She was taken to the hospital in a cab, where an attempt was made to fit on one of the splints used by Dr. Matas. This was one of the early models, consisting of a single mouth-piece, which was permanently attached to the clamp. This was found too long to fit, and a simple bandage, with a chin splint, was substituted

FIG. 7.

E. B., struck on the jaw with a club; compound fracture. Lower jaw broken completely between left external incisor and canine. Splint worn twenty-eight days without inconvenience and with perfect results.

FIG. 8.

J. H., compound fracture of lower jaw, caused by fist blow. Line of fracture oblique, bisecting lower jaw at angle and terminating above behind last molar tooth. Great displacement and mobility of fragments. Reduction and apposition only obtained by splint. Barton bandage used to immobilize jaws with the splint, Splint worn eighteen days, and followed by excellent results.

FIG. 9.

A. S., lower jaw fractured by falling on a tree while alighting from a car in motion. Double compound fracture. One line of fracture dividing the body of the jaw obliquely at angle on the right side; the other broke the body of bone between the left lateral incisor and canine. Reduction and permanent apposition impossible until the splint was applied. Excellent functional and anatomical results after wearing the splint for twenty-one days.

FIG. 10.

Miss N. F., lower jaw broken by fist blow. Oblique simple fracture of body on level with second molar; submucous break, with lateral displacement of left bicuspid and large fragment of alveolus. Perfect result after wearing splint seventeen days.

for it. On the second day after the injury she applied directly to Dr. Matas for treatment at his private office, where a model of the splint similar to the one used in the hospital was adjusted to her dental arch, but not until the interdental piece or gutter had been shortened. After this alteration the splint fitted perfectly, and the fragments were held in perfect apposition. She was taught how to irrigate her mouth and wore the splint constantly without any other bandage or restriction to the movements of the jaw. The splint was removed seventeen days after it had been applied, when it was found that the union was sufficiently firm to dispense with the appliance. There was no deformity or appreciable irregularity in the line of the teeth. The splint was removed every day for a week, and then every second day, to change the padding under the chin and to wash the skin with alcohol. The ease with which this patient could speak, eat, and drink with the splint on was remarkable.

Case VI. (Reported by Mr. Sistrunk, interne, Charity Hospital.)—R. A. T., male, aged twenty-five years. On May 22, 1904, while boxing with a friend (both using boxing-gloves), he was struck on the right side of the lower jaw. He suffered excruciating pains and could scarcely talk. He came at once to the hospital, where he was found to have a *compound transverse fracture of the right half of the lower jaw, midway between the symphysis and the angle.* The teeth upon the side nearest the angle of the jaw were raised above the others, and the broken ends of the bone could be seen protruding through the lacerated wound in the gum. After reducing the fracture, the splint devised by Dr. Matas was applied and held the fragments in perfect apposition. The splint gave him almost instant relief, and after its application the patient could easily talk and swallow without much pain. He returned the next day, and the splint was removed and the mouth irrigated with a 1 per cent. solution of carbolic acid. The removal of the splint was followed by considerable pain, and the patient begged to have the splint replaced. This was repeated every day for ten successive days, when it was found that the bones remained in position without the splint. By this time an ulcer had developed under the tongue,

which was attributed to pressure. In consequence of this ulcer and the fact that the bones had united sufficiently to prevent displacement, the splint was removed. The patient was discharged on June 3d, at his own request, with a Barton bandage put on to hold the dressings under the chin and as a protection against displacement of the fracture. When he was discharged no motion or crepitus could be obtained and the teeth were on a level.

ANKYLOSIS. ARTHROPLASTY—CLINICAL AND EXPERIMENTAL.

By JOHN B. MURPHY, A.M., M.D.,
CHICAGO.

The subject of ankylosis and its treatment presents many problems for consideration. In order to immediately emphasize the salient points of the subject, we will ask some questions: What are joints? What is the embryology of joint formation? What is the pathological histology of acquired arthroses or false joints? What is the pathology of hygromata (acquired endothelial-lined sacs)? Can they be produced artificially? What is ankylosis? What are the pathological and anatomical changes included in the term? What tissues are involved? From a practical standpoint, into what classes may it be divided? When ankylosis has formed, what are the limitations of surgery for its relief? Can we re-establish a movable, functionating joint with synovial lining? Can we restore motion and to what degree? In what class of cases can the best results be secured? Can we for the future promise better than the flexible, fibrous unions that we have secured in the past?

These were the questions that most forcibly presented themselves when I began the investigation of this subject in July, 1901. Subsequent experience has shown that the majority of these have been answered favorably from a clinical standpoint. Experimental work on joints in dogs is unsatisfactory on account of the difficulty in controlling infection and motion. A preliminary report of this work with demonstration of one of the cases was made to the Chicago Surgical Society at Mercy Hospital, October, 1902.

ANATOMY AND EMBRYOLOGY.

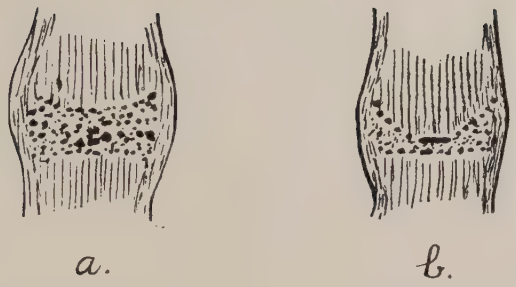
The classification of joints from a practical standpoint is as follows: The synarthrosis, the amphiarthrosis, and the diarthrosis. The subdivisions of the latter, the ginglymus (elbow, ankle, wrist, etc.), the ginglymo-arthrodial (knee, temporomandibular), and the enarthrodial (shoulder and hip) are the only joints which concern us in this class of surgical work. The types of motion which are present in these joints are the hinge, which is the sliding, rotary motion of the elbow, knee, temporomandibular articulations, and the rotary motion of the forearm, shoulder, and hip; the two latter are the most favorable for the restoration of motion after ankylosis, as the degree of sliding motion is extremely limited compared with that of the elbow and knee. The histology of joint formation is best illustrated by the works of Hertwig, Meyer, and Gegenbaur, and may be summed up as follows:

Diarthrosis is a differentiation of primitive synarthrosis, of which it is a transformation. This mode of union exists almost exclusively between parts of the skeleton and is preceded by preformed cartilage during their development. When a joint is formed between two bones which are not developed from primordial cartilage it is formed secondarily from cartilaginous tissue between the rudiments of these bones.

The origin of joints seems to be in connection with the differentiations and perfection of the cartilaginous parts of the skeleton. These are separated for a long time by interposed indifferent tissue (Fig. 1, *A*). At the same time that the cartilaginous elements of the skeleton increase, the interposed connective tissue which separated them at first is itself transformed into cartilage and disappears. Fig. 1, *B*, shows the beginning of this cartilage formation at the expense of the interposed connective tissue.

At the end the two terminal cartilaginous surfaces of the two skeletal organs are found in immediate contact; they each have a predetermined form characteristic for each joint. The two contiguous extremities of the skeletal parts are found separated

FIG. 1.



a. Indifferent tissue interposed between ends of developing bones. *b*. Beginning cartilage formation in interposed tissue. (Gegenbaur.)

FIG. 2.

Cartilaginous tissue between ends of developing bones. (Gegenbaur.)

FIG. 3.

a. Joint cavity and articular cartilages formed by division of intermediate cartilage. *b*. The external connective tissue, which is continuous with the intermediate tissue, forms the joint capsule. (Gegenbaur.)

by a mass of cartilaginous tissue, formed at the expense of the primary intermediate tissue (Fig. 2).

A slit, at first very delicate, soon appears in this intermediate cartilage, which separates it into two layers, one and the other applied against the terminal surfaces of the cartilaginous skeletal parts. These layers constitute the articular cartilages (Fig. 3, *A*). At the same time the slit has become more extensive—the joint cavity; it separates the articular surfaces of the two bones. Externally the joint cavity is limited by connective tissue extending from one skeletal piece to the other. This connective tissue is continuous beyond the joint surfaces with the periosteum (perichondrium) of the two developing bones. It is this connective tissue surrounding the joint cavity which gives rise to the joint capsule (Fig. 3, *B*). The external layers of this tissue are differentiated into a fibrous membrane, generally tough, called the capsular ligament. Its inner, softer layer is turned toward the joint which it bounds. It is richly vascular and constitutes the synovial membrane.

The capsular ligament is not equally developed over its whole extent. It remains thin in certain places, and thickens, on the contrary, in others, so as to form bundles of more rigid tendinous fibres. These bundles develop in a given direction, acquire a variable freedom, and may even become completely separated from the capsular ligament. Thus are formed the accessory or auxiliary ligaments.

The intermediate interposed tissue, which existed in the rudimentary joint, is not always entirely used up in the increase of the articular ends of the bones. When the joint surfaces do not correspond closely to each other, remnants of this tissue persist at the periphery of the joint cavity united to the synovial membrane of the capsule. These remnants project into the joint cavity and constitute prolongations or folds of the synovial membrane.

In other cases the differentiation of the contiguous articular ends does not go so far. The two articular surfaces do not touch over their whole extent but only over a part of it; in this case a larger part of the intermediate tissue persists in the joint capsule.

The joint surfaces are thus more or less discordant. This intermediate tissue is then transformed into fibrocartilage and constitutes an organ which on cross-section is semilunar in shape (Fig. 3, *A*).

In some cases a continuous joint cavity is not formed, the embryonic intermediate tissue being less utilized in the formation of the articular cartilages. Before the transformation of the articular surfaces in contact can take place, a slit appears between the joint surfaces and the intermediate tissue, which develops into a joint cavity. It follows that each of the articular ends will be lodged in a special joint cavity, separated from the one containing the other bone by a layer of intermediate tissue. This latter is finally transformed into an interarticular cartilage, separating the two articular cavities of the same joint, as in the temporomaxillary articulation. These interarticular cartilages may be continuous or discontinuous. When they are discontinuous, as is the case with the semilunar cartilage, the two special joint cavities are incompletely separated from each other. When they are continuous, on the contrary, the joint cavities are completely separated by them. In both cases they are the remains of the primitively continuous intermediate tissue.

The first stages of joint development occur during fœtal life, when no muscular action is present. The characteristic features and disposition of the joint surfaces are already formed before the joint can functionate. The final transformation—*i. e.*, the extension of the joint cavity, etc.—only occurs after the joint is put to use. It is determined by the skeletal movements and by muscular action (Gegenbaur).

The wrist and ankle have a purely endochondral ossification (Hertwig-Mark, *Text-book of Embryology*); the cells of connective tissue grow into the cartilage from the perichondrium, dissolve the matrix of cartilage and unite with one another in the centre. There arises a network of medullary (marrow) cavities in the vicinity of which there is a deposit of salts of lime (a provisional calcification). The medullary spaces extend farther and farther by destruction of the cartilaginous substance. Then there

are secreted by the superficially located medullary cells, bone lamellæ, which gradually increase in thickness. The osseous nucleus thus formed slowly increases in size, until finally the cartilage is almost entirely replaced, only a thin layer of it remaining at the surfaces as a covering for the bone.

The question whether the extremities of bones, the articular surfaces, are subjected as far as their form is concerned to mechanical laws only was much discussed. According to Bernays, the early and typical form of joints appears to be a matter due to heredity. The muscles also have a decided influence upon the later forms of articular surfaces.

According to His, the development of the body of vertebrates in the ovum is determined and controlled by mechanical laws, while Haeckel considers heredity as a determinant factor.

L. Fick states that at the end of the second month the joints show a tendency for shape, still "the greatest irregularity exists in the form of articular surfaces." There are no two joints alike, at that period, among the articular surfaces of phalanges.

In regard to the question, What determines the form of articular surfaces, Fick has shown in his monograph that muscular activity is responsible for the peculiar form of the different articular surfaces. By experimenting upon young dogs, he noticed that section of muscles is followed by a change in the form of the corresponding articular surfaces and also of the interarticular space. By experimental immobilization of the joints of growing dogs, the space and form of articular surfaces was changed; the interarticular line became irregular.

As to the question, Why it is that one extremity of bone becomes a prominent surface, while the next extremity of bone becomes an articular cavity, several explanations are given.

Fick says that beside the muscular activity, on account of more active circulation, the multiplication of cells is more marked in one end than in the other, so that it penetrates the latter and forces it to excavate.

Henke and Reyher explain it by the fact that the muscles force the bone, on which the insertion is nearer to the articular surface,

against the other bone, on which the insertion is farther from the interarticular line, so that it determines the formation of a cavity by means of pressure in the former.

The essential phenomena, says E. Retterer (*Comp. Rend. Soc. de Biologie*, 1894, p. 862), concerning the formation of the joint cavity take place when the cartilaginous segments are nearly in contact and before there is any articular slit. We find that at this stage the superficial layers of the cartilaginous segments are not yet free; the flattened and crowded cells limiting these segments are succeeded by a much clearer connective tissue. This is made up of fusiform and stellate cells whose numerous prolongations enclose meshes filled with Wharton's jelly. In other words, the embryonic connective tissue which is not transformed into cartilage has developed into mucous connective tissue in the interval between cartilaginous segments where the future joint is to be. Little by little these meshes become larger and larger, the prolongations of the cells more and more thinned; the cell body less and less clearly outlined, staining with difficulty. In short, the cells with their prolongations atrophy, and with the nuclei disappear; at the same time the joint surfaces become free. By undergoing mucoid transformation in the interval between the cartilages, the embryonic connective tissue gives rise to the first synovial fluid. On the inner side of the joint capsule the connective tissue persists as closely packed elements and gives origin to the synovial membrane which is lined with many tiers of flat cells. Hence there are the following stages in the formation of a joint cavity:

1. Existence of an embryonic connective tissue with closely packed cells.

2. The production of fusiform and stellate cells whose prolongations anastomose.

3. Elaboration of mucoid substance in their meshes.

4. Atrophy of the cellular elements and their prolongations.

The joint cavity succeeds the evolution of this embryonal connective tissue, which in place of producing cartilage or bundles of areolar tissue, elaborates the mucoid substance giving rise to the first synovial fluid.

Every joint begins by a stage where the segments present are

bound together by a compact connective tissue, which establishes their *continuity*. While most joints remain thus, we see in movable joints this connective tissue persisting only at the capsules, ligaments, etc., which becomes fibrous, fibrocartilaginous, or even osseous tissue.

But at the places where the skeletal segments come in contact, their *continuity* is changed into *contiguity*, because the thin layer of intervening connective tissue has disappeared by mucoid degeneration. In other words, *every diarthrosis passes through a transition state which may be compared with an amphiarthrosis.*

HYGROMA (BURSÆ).

While in the embryology of joint formation always primarily formed without a cavity, a splitting or liquefaction of cartilaginous or connective tissue between the cartilages takes place, the superficial bursæ are made by the same splitting between fat capsules (subfascial) on aponeurotic mesoblastic tissue (Langemak, *Arch. klin. Chir.*, Bd. lxx., Heft 4, page 946). Fat tissue rapidly or easily changes to connective tissue. Bursæ formation is due to the absorption of fat from fatty tissue and the coalescence of the small fat capsules with an increase or hyperplasia of the connective tissue with its degeneration or development of collagen.

It is the solution of liquefaction of the collagen in the centre that forms (fibrinoid—a degeneration product) the fluid in the cavity of the bursa. The fluid is a liquefied collagen, not a secretion from the surface of the cavity (serous) as Virchow taught. The "rice bodies" are dead proliferations of partially developed tissue or fibrin of the small villi or "zotten."

Hygroma (bursæ) is then the result of a degenerative or absorptive process in fatty tissue with hyperplasia of the connective-tissue element, the segmentation of the collagen into solution, "fibrinoid," a liquefaction of hypertrophied connective tissue. The cells lining the newly developed cavity appear as flattened endothelial cells; these are really transformed connective-tissue cells.

The hygroma has no vessels and, therefore, cannot become inflamed. It may be the centre of phlegmon and necrosis, but is

not itself a part of the process. (It cannot be cured by drainage unless necrosis takes place, but can be cured by extirpation.) Hygromata and ganglia are the combined products of liquefaction of hypertrophied connective tissue.

In the artificial development of joints it is important to utilize these facts. The aponeurosis that is to be used in the construction of artificial joints *should have in it a considerable quantity of fatty tissue* which when subjected to pressure forms the hygroma. This is not infrequently seen in the non-union of fractures in the shafts of the long bones, forming what is known as the false joint or interosseous sac. It is the recognition of this pathological condition that has led to its utilization in arthroplasty. That this sac with a lining resembling endothelium is formed was demonstrated beyond question in the animal experiments reported later.

EXPERIMENTS.

No. 1. Large white dog. Operated December 15, 1903. Operation:

a. U-shaped incision over right hip.
b. Skin and fascia lata reflected upward.
c. Great trochanter divided by chain saw and upper fragment, with muscles, reflected upward.
d. Head of femur dislocated from acetabulum.
e. Cartilage gouged out of acetabulum and removed from head of femur.
f. Fascia lata dissected from skin flap and brought down in front of muscles attached to great trochanter.
g. Fascia lata sutured with kangaroo tendon around neck of femur so that muscular surface of the fascia would line the inner surface of the acetabulum.
h. Edges of fascia then drawn together over head of femur, thus capping same—kangaroo tendon sutures.
i. Head of femur returned into socket.
j. Upper fragment of trochanter sutured to lower.
k. Skin returned and sutured in place—horsehair.
l. Collodion dressing.

The dog did not use operated extremity at all in locomotion. The thigh was carried slightly flexed on the abdomen and hung limp. He was fat and playful.

The dog was killed with chloroform April 12, 1904. After death free passive movement in every direction was demonstrated.

A complete dissection of the joint was made and the following conditions noted: The muscles about the joint were atrophied and there was considerable scar-tissue formation at the site from which the flap was dissected and around the joint. Interposed between the upper extremity of the femur and the acetabulum there was a small sac with a smooth lining. It contained a small amount of slightly turbid, sticky fluid. Its total surface was about that of the normal acetabular cavity. The end of the shaft of the femur where the cartilage had been taken off was smooth and covered by the newly formed synovial endothelial lined membrane. About the sac there was a moderate amount of newly formed connective tissue. Sections were made from the sac wall and examined under the microscope. They showed on the inner surface a well-formed endothelial lining. The nuclei of the cells were elongated and the cytoplasm stretched out so as to form a thin, homogeneous membrane. Beneath this one-celled layer was a vascular connective-tissue matrix with cell running in all directions. There were a large number of polymorphonuclear leukocytes present, probably indicating a recent inflammatory reaction.

No. 2. Black and white dog; male; weight about thirty pounds. Operation December 8, 1903.

Placing of flap of fascia lata in hip-joint to determine subsequent changes in fascia.

Steps of Operation:

1. U-shaped incision over hip-joint, concavity upward. Great trochanter in centre of U.
2. Incision through fascia made wider than that through skin.
3. Dissection of skin and fascia in one flap.
4. Great trochanter severed by chain-saw and upper fragment, with attached gluteal muscles retracted upward.
5. Capsule of joint incised and removed.

6. Head of femur dislocated from acetabulum.

7. Cartilage and synovial membrane in acetabulum removed with curette.

8. Cartilage on head of femur removed with cutting forceps.

9. Fascia lata on under side of flap dissected from skin and swung down in front of the gluteal muscles attached to trochanter—the fascia retaining its attachment to skin by a fairly broad pedicle.

10. Fascial flap fitted in acetabular socket and sutured with kangaroo tendon to periosteum on posterior surface of neck of femur, the muscular surface of the fascia lata being in contact with the acetabulum, while the fatty surface came in contact with the head of the femur.

11. Head of femur replaced in acetabulum.

12. Another kangaroo suture was passed through fascia and the periosteum over the still intact part of greater trochanter in order to anchor flap still more securely.

13. Two parts of greater trochanter approximated with kangaroo tendon.

14. Collodion dressing.

Condition December 12, 1903: Wound clean; no tenderness. Dog does not eat very well. Limps about a little. Dog died December 20, 1903. Post-mortem findings: (*a*) head of femur dislocated from acetabulum; (*b*) fascia lata sloughed away; (*c*) muscles and joint filled with pus.

Ankylosis is a generic term and does not represent a pathologic entity. It is due to varied pathologic conditions; it involves many tissues, either separately or combined and may be classified as:

- Ankylosis (true and false)
  - Periarticular
    - Capsular.
    - Extracapsular
      - Tendinous.
      - Tendovaginal.
      - Muscular.
  - Articular . . .
    - Synovial—fibrosis.
    - Cartilaginous.
    - Osseous.

In the periarticular variety, when the capsule is the seat of the disease which produces the immobilization of the joint, it is

infiltrated, indurated and adherent throughout the surface of the joint, thus limiting the motion. The extracapsular varieties include the inflammation and adhesions of the tendons and tendon sheaths, as well as the muscular agglutinations at, and close to, the joint. These may not include the capsule at all, the entire restraining structures being extracapsular. These lesions differ entirely from the articular variety of ankylosis, when the lesion is in the synovial membrane, which has lost its endothelial lining and has undergone fibrosis and transarticular union.

The cartilaginous variety exists when the synovial membrane has undergone complete destruction and there is a union of the cartilage or cartilaginous remnants with no vestige of the synovial structure remaining.

The most serious type of ankylosis is that in which the synovial membrane and cartilage have disappeared and osseous union has taken place between the apposing bone ends.

The last three types of ankylosis will more particularly concern us in this paper.

ARTHRITIS.

The types of arthritis which lead to the varieties of ankylosis mentioned above may be classed as follows:

- Arthritis
  - *a.* Primary hæmatogenous fibrous arthritis.
  - *b.* Dry fibrous arthritis. Non-traumatic.
  - *c.* Traumatic fibrous arthritis
    - With fracture into joint.
    - Without fracture; contusion.
  - *d.* Suppurative arthritis
    - Hæmatogenous
      - Cryptogenic.
      - Metastatic
        - Typhoid.
        - Scarlatina.
        - Pyæmia.
        - Gonorrhœa.
      - Traumatic.
    - Extension
      - Osteitis
        - Tuberculous.
        - Osteomyelitic (infective).
      - Periarthritis. Phlegmon.
      - Panarthritis.
  - *e.* Ossifying arthritis. Primary.
  - *f.* Static adhesive.

The primary hæmatogenous fibrous arthritis is usually ushered in with a chill followed by intense pain and sensitiveness in one joint, rarely more, accompanied by a high temperature and pronounced manifestations of sepsis with only moderate effusion into the joint cavity. The diagnosis is usually monarticular rheumatism. It is not a rheumatism in the common acceptance of the term, either in its etiology, clinical course or final result. It is an acute, virulent, synovial infection followed by necrosis of the endothelial and subendothelial tissue, with subsequent organic union. It lasts for many weeks and even months. It is not associated with urethral infection and terminates with a fibrous ankylosis and agglutination of the capsule; the periarticular tissues (tendons, etc.) are usually not involved. This has an entirely different clinical course from the dry, fibrous arthritis; in this there is no evidence of septic intoxication, no effusion into the joint, practically no constant pain; there is sensitiveness to motion, which gradually becomes more and more limited until it entirely ceases and there is formed a fibrous adhesion of the approximated surfaces. Both of these varieties differ from the traumatic fibrous arthritis, the one following fractures into the joint and resulting in complete agglutination of the surfaces and fixation of the bones. This is fortunately a rare result of fracture; it occurs most frequently in the shoulder, elbow, and knee.

The traumatic fibrous arthritis, without fracture, is not uncommon and gives a lamentable result from a comparatively slight injury. For instance, a patient falls and strikes on the elbow; the trauma is accompanied by pain; the surgeon is consulted and carefully examines the part and determines that there is neither a fracture nor luxation. The first few days after the accident it is comparatively painless; in a week or ten days the pain increases and continues to increase for from three to four weeks, when motion in the joint becomes intolerable and, even under force, very limited. The limitation of motion becomes more and more marked and at the end of twelve weeks ankylosis, to the horror of the patient and chagrin of the surgeon, is complete. Although the surgeon is in no way

responsible for this condition, he is severely criticised; we know of no means of avoiding this catastrophe. It seems to be an idiosyncrasy to connective-tissue formation in the joints of some patients, resembling the keloid tendency in the skin of others. Fortunately the joints which tend most to this type of arthritis are best adapted to arthroplastic procedures. Here, too, the periarticular tissues are not involved.

The type of arthritis which most frequently results in ankylosis is the suppurative, and of this—the hæmatogenous variety is the most severe and destructive in its nature. Of the cryptogenic variety we not infrequently see an acute, virulent, purulent inflammation of a joint without knowing where the primary infected focus existed or the primary atrium of blood invasion occurred. This type is more severe and destructive to the elements of the joint than the type usually recognized as metastatic and the sequence of typhoid, scarlatina, pyæmia, or gonorrhœa. The typhoid type of articular infection, as emphasized by Keen, may be divided into two great classes, namely, the mixed infection (pyæmic and typhoid) variety and the pure typhoid variety. The former usually terminates fatally and, if the patient survives, the treatment of the ankylosis following would come under the same treatment as for ordinary pus infection. The hip is the joint of election in typhoid, as well as in scarlatinal infections. This arthritis is so severe in degree that in over 50 per cent. of the cases it is accompanied by luxation. The tendency is not to suppuration in these cases, as pus rarely forms; but it is often associated with osteitis and softening. The scarlatinal infections of the joints are rarely accompanied by destruction of the synovial membrane or cartilage; they are of the purulent or seropurulent varieties, which develop rapidly, require simple drainage and are followed by a complete restoration of the joint. In the more destructive varieties, however, they are followed by destruction of the synovial membrane and cartilage and this by ankylosis without much involvement of the periarticular tissue. The pyæmic variety usually terminates fatally; when the patient survives, the conditions remaining are the usual sequelæ of pan-

arthritis, with bony ankylosis. Following gonorrhœa, we have three types of arthritis—the *chronic, painful, dry,* extending over months and even years and followed by a plastic, adhesive synovitis; the *acute and subacute serous* synovitis, which runs rather a rapid course and terminates without ankylosis, and the *mixed infection* variety, which terminates in suppuration, synovial necrosis, fibrous or bony ankylosis without involving the periarticular tissues.

Traumatic suppurative arthritis may be classified into the non-penetrating and penetrating. Suppuration of the joint following a trauma may occur without an abrasion or laceration. It is usually, however, secondary to a traumatic osteomyelitis which subsequently affects the joint and occurs much more frequently in the young and growing. The penetration of the joint from without inward may be considered as puncture and stab penetrations and bullet wounds. Since antiseptic surgery with the immediate sealing of penetrating stab and puncture wounds has become the practice and the probe condemned, suppuration rarely follows these types of punctures. The same may be said of bullet wounds, but in civil practice, bullet wounds are more frequently followed by infection than in the recent military cases. When evidence of infection is manifest, free drainage without the use of antiseptics or manipulation is all that is indicated and gives fairly good results. It must be timely and must relieve the pockets of the joint and its periphery. When perforations occur from within outward as in compound fractures and luxations, when the joint is opened by the protrusion of bone through the soft parts, the danger of infection is very much less, or practically *nil*, if care be taken to immediately seal the wound and exploration withheld. These cases do not require drainage. Hermetical sealing of this class of injuries has given the most brilliant results —the most positive proof of the value of asepsis. We recall that in Billroth's *Surgery and Surgical Pathology* (translation of 1876), amputation was advised for all compound fractures complicating joints. When, however, at the present time infection takes place they are frequently followed by ankylosis and many times by

deformity. The latter is avoidable if care be taken to keep the limb in proper position, either by extension or mechanical support, while the pathologic process is going through its course. I am sorry to admit that the profession has been very derelict in its prophylaxis of this type of deformity.

Osteitis of the tuberculous type is probably the most common cause of ankylosis. While pathologically we have primary tuberculous synovitis, *practically all cases of tuberculosis in joints are secondary to a primary focus in the bone* usually near the junction of the diaphysis and epiphysis. This tuberculous granuloma enlarges, softens the bony structures, frees the cartilage and finally ruptures into the joint, there producing a tuberculous arthritis. If a mixed infection exists the destruction of the joint will be rapid, the capsule ruptures and the pus discharges. If it be simply tuberculous infection, the process of destruction of the cartilage and synovial membrane is slow, but nevertheless effectual and finally results in a partial or complete bony ankylosis, or a fibrous organic union of the two bones. The frequency of the osseous origin of tuberculous arthritis may be judged from my experience with the knee-joint. In 128 cases of tuberculosis of the knee in all but two it could be clearly demonstrated that the origin of the disease was in the bone. In one of the two it was doubtful and in the other it appeared to be a clear case of synovial tuberculosis. In a large percentage of the cases on which I did excisions, I feel now that the bony destruction was of such mild degree, that an interposition arthroplasty might have been performed, and the motion in the joint restored. From observation, I would consider tuberculous synovitis of the hip to be more frequent than tuberculous synovitis of the knee, but the difficulty of carefully examining the head of the femur and acetabulum may account for the apparent disparity. In planning to operate on these cases for the restoration of motion, the question of luxation or subluxation must be given grave consideration. As restoration of position is a very difficult undertaking.

Osteomyelitis of the epiphyseal or "end" type of the British

authors not infrequently secondarily infects the joint and produces extensive destruction of cartilage, synovial membrane and bone ends even to a panarthritis, to be followed later by an osseous ankylosis. It differs from tuberculosis in the fact that the tuberculous process does not affect the joint or bone to an incapacitating degree until five to seven weeks after the trauma or exposure, while the osteomyelitic processes produce profound manifestations, both local and constitutional, as pain, swelling, arthritis, effusion, etc., with chills, high temperature, delirium and severe septic intoxication within forty-eight to ninety-six hours after the trauma or exposure. The clinical history of the onset of these two diseases is so clean cut and distinctive that they cannot be confused if carefully analyzed. The periarticular involvements following acute septic osteomyelitis may lessen the chances for free motion after operative procedure.

Periarthritis due to phlegmonous inflammations in the neighborhood of joints not infrequently inhibit or entirely obliterates motion by its fixation of the periarticular tissues (ligaments, tendons, etc.); if fibrous synovitis, however, does not result and the joint is not penetrated by the infection, a fair degree of motion may be secured. If the joint has been penetrated by the infection all of the tissues of the joint may be involved and a panarthritis is the result.

In panarthritis the bone, cartilage, synovial capsule and periarticular tissues are infected, no matter in which tissue the primary focus originated. This type of inflammation frequently results in luxation, adhesion of the tendons, even ulceration and necrosis of the capsule, ligaments, bone and muscular tissue around the joint, so that a complete luxation of the bone follows. (I recently saw a case of this type with infection of the hip-joint.) The destruction of the tissues here may be so complete that no effort at the restoration of motion should be attempted.

Primary ossifying arthritis is a rare type of joint disease, not associated with pronounced inflammatory symptoms, insidious in its onset, slow in its advancement but resulting inevitably in osseous ankylosis. Fortunately it usually occurs in patients

beyond middle age, and attempts at restoration of the joint should not be made.

Static adhesive arthritis is a sequence of prolonged fixation. This fixation may be due to diseases of the bones which make up the joint, or it may be due to periarticular inflammations or traumas. There is rarely ever an osseous ankylosis as a sequence of this trouble. The capsule, however, becomes firmly united to the cartilage and the endothelial layer of the synovial membrane is destroyed. There is, in other words, a fibrous synovial fixation. Here, before undertaking operative procedure, an accurate estimate must be made of the part played by the periarticular tissues, rather than the adhesive synovitis. In burns, extensive phlegmons, severe contusions, the cicatrices around and in the neighborhood of the joints produce ankylosis, which may or may not be associated with adhesive fibrinous synovitis. If these cases are operated early after the process of repair of the soft parts is complete, the joint will not have to be opened, the periarticular cicatrices demanding our entire attention. The most pronounced example of this type is the mandibular fixation following ulcerative stomatitis or noma.

TREATMENT.

Treatment must be directed against any one of these types of the anatomic-pathologic conditions:

Treatment.

- A. Extracapsular disease . . .
  1. Tendon elongation—(tendoplasty).
  2. Tendovaginitis (exsection of sheath).
  3. Cicatrices—removal.
- B. Capsular . . . .
  1. Adhesive synovitis—exsection of capsule.
  2. Replacement by aponeurosis or muscle.
- C. Osseous . . . .
  1. Disconnect bones.
  2. Remove neighboring bony processes or prominences.
  3. Liberate soft parts.
  4. Prevent subsequent bony contact.
  5. Interpose tissue to form hygroma or fibrous surface.
- D. Joints, operable
  1. Mandibular.
  2. Hip.
  3. Shoulder.
  4. Elbow.
  5. Knee.
- E. Technique . . .
  1. Flap formation (skin flap with fascia, or muscular).
  2. Exposure of ankylosed area.
  3. Osseous separation.
  4. Transplantation and fixation of interposition flap.
  5. Replacement of bone.
  6. Fixation of parts.
  7. Drainage.
- F. Subsequent treatment . . . .
  1. Passive motion.
  2. Active motion.
  3. Forcible extension.
- G. Prognosis . . .
  1. Mandible.
  2. Hip.
  3. Shoulder.
  4. Elbow.
  5. Knee.

The treatment of ankylosis in the past consisted principally in forcible separation of the adherent surfaces and an endeavor to maintain motion after the adhesions had once been freed (*brisement*). In a very small percentage of the cases, namely, those of synovial adhesion without organic union, the result was gratifying. In the enormous percentage of cases where the lesions were due to necrosis of the synovial membrane or to fibrous or osseous union of the articular surfaces, ankylosis recurred after *redressement* and the limb was in as bad if not a worse condition than before.

Schuh, in 1853, mobilized the patella with the chisel by cutting the synechia, but interposed nothing and the ankylosis recurred. Cramer says in his excellent article before the Thirtieth Congress of the Deutsche Gesellschaft f. Chirurgie in Berlin, April 13,

1901, that the adhesions separated by forcible distention (Ollier), by the mallet (Hueber), or by the chisel (Schuh), have been rarely successful and the Brachi method of establishing movement of the patella by manipulation was equally unsatisfactory.

Helferich, in 1899, proposed to free the patella with a chisel and interpose some of the vastus internus between the patella and femur and prevent adhesion. He did not perform the operation.

Cramer (*Arch. f. klin. Chirurgie*, 1901, Bd. lxiv., p. 696) saw 10 cases of ankylosis of the patella and operated on 7 by interposition of the vastus internus, 6 of which were successful. This does not imply ankylosis of the knee-joint, but of the patella alone.

Verneuil and Helferich preceded him in this idea, both in suggestion and performance by the interposition of portions of the muscle and fascia in temporomaxillary ankylosis.

Chlumsky, under date of September 15, 1900 (*Centralblatt f. Chirurgie*), states the following: "The treatment of complicated contractures and ankylosis of the joints as far as *restitutio ad integrum*, gives very unsatisfactory results. I have myself collected 14 cases of ankylosis, other than tuberculosis of the knee-joint, with contraction, which occurred in the last ten years in the Breslau Surgical Clinic and were there treated, and in not a single case was there improvement in the mobility of the joint." He found also no better results recorded in the literature on the joints, and for that reason undertook experiments to endeavor to clear up the question. He then attempted through forcible extension and flexion, repeatedly done under anæsthesia, to secure mobility of the joint; *after each trauma there was additional deposits of osseous and fibrous tissue and the cases were uniformly worse after than before the operation.* He reasons that the interposition of muscle or fascia such as takes place in pseudarthroses after fracture, should give good results, as was suggested by Verneuil and also used by him in the inferior maxillary articulation. Good results in this line were obtained by Mikulicz, Helferich, Lenz and Riegner, and with this knowledge *Chlumsky concludes that in*

large joints this procedure is not possible, either through failure of preservation of the interposed part, or on account of technical difficulties. [Italics mine.]

Not satisfied to abandon the field he decided to resort to the interposition of foreign bodies and conducted a large number of experiments. The materials used were plates of celluloid, silver, zinc, rubber, cambric, and layers of collodion, and while he succeeded in retaining mobility with these interposed materials in some cases, a fair preservation of articulation beyond four and one-half months was not obtained and ankylosis had to ultimately occur, and the foreign body become extruded from the joint. He, therefore, concluded to substitute for the unabsorbable material absorbable material such as decalcified bone, ivory, magnesium, etc. In these at the end of three to twelve weeks he found various degrees of absorption and in some a moderate attempt at the formation of a joint, but with very unsatisfactory results on the whole.

At this period, October 5, 1901, I performed my first operation, Mr. D. (full particulars given under the heading of report of cases).

Hubscher (*Corresp. Blatt. f. Schweiz. Aerzte*, Bd. xxxi., p. 785) used a magnesium foil, 5 mm. in thickness, in ankylosis of the patella. Speaking of the different methods and experiments he mentions Bruns who has successfully transplanted the flexor tendons after five years of adhesion. He failed to secure freedom of the patella.

McIlhenny (*New Orleans Medical Journal*, April, 1901) operated for temporomaxillary ankylosis by osteoclasis and formation of new joints. The details of this operation were as follows:

An Esmarch's incision was made on the right side, exposing the jaw bone from the sigmoid notch to a point a little anterior to the angle. The masseter was retracted and a wedge of bone one-half inch in diameter was removed from the neck of the condyle just above the insertion of the external pterygoid. The same step was followed on the opposite side, with the result that the mouth could be opened to almost normal. The tongue was found attached and carefully freed. The ends of the bone were rounded off and

the cavity packed with iodoform gauze. Bands in the side of the mouth gave trouble and these were stretched or divided and the external wound finally closed. The patient was able to chew for the first time in fifteen years.

[From the description given of this case I infer that the union was a fibrocartilaginous one and not the formation of a new joint. Shortening the neck and removing the head of the mandible allowed the temporal and masseter muscles to act as a pivot on which the jaw revolved. The practical result was excellent.]

Gluck, of Berlin, at the Thirty-first Congress of the Deutsche Gesellschaft für Chirurgie, Berlin, April 2 to 5, 1903, presented a little girl whom he had treated for gangrenous stomatitis and septic phlegmon of the mouth. The alveolar process and the teeth were gone. The cicatricial tissue was removed after Gussenbauer's method and the flap of skin transplanted into the mouth. He referred to two other cases of bony ankylosis of the temporomaxillary articulation. The joints were mobilized; the wound was tamponed. Ten days later with the hammer and chisel, portions of the bone were removed. A cutaneous wedge was implanted with attachment to the bony surfaces, to interpose and prevent union. It healed, and the mouth could be opened to the maximum. He believes the cutaneous flap is the best for this purpose. He promised a more complete report later, which did not appear.

A. Blencke (*Zeitschrift f. Orthoped. Chirurgie*, Bd. viii., Heft 1) advocates conservative treatment of these joints with the apparatus of Lorenz and Helferich.

Calot does not believe in force or violence in the restoration of motion in ankylosed joints.

Golobiewski recommends his apparatus for the treatment of ankylosis and says he has very good results. [If by this he means good results where bony or fibrous ankylosis existed and the synovial membrane and cartilage had been destroyed, it does not correspond with our knowledge of the process of repair of these surfaces under such circumstances. I, therefore, believe that he must have referred to the purely adhesive cases of arthritis.]

In treating ankylosis the first propositions are: What is the type of ankylosis? What tissues are involved? What are the pathological lesions which produced the ankylosis? With these questions answered, we can take up the individual cases and the technique involved in each.

In the extracapsular variety, elongation of the tendons should be performed; by that I do not mean forcible elongation, I mean *plastic* elongation, and either by tendoplasty or myoplasty. The forcible elongation of a muscle or tendon that has been fixed for a long time is very unsatisfactory, both in its immediate and ultimate results. Tendoplasty properly performed is a safe and rational procedure and tends to immediate and permanent restoration of function.

Tenotomies and myotomies in all muscular contraction for forcible extension fail to give free motion in the joint. Plastic elongation of the muscles gives very desirable results. The extensor tendons should always be given the advantage as they are always weaker than the flexors. A portion of the true capsule of the joint can be dissected from beneath the quadriceps tendon, and spread out over the surface of the femur in cases of ankylosis of the tibia. This will least interfere with the functions of the joint. It is possible that this capsule may be utilized to cap the end of the femur in tibiofemoral ankylosis.

Where a tendovaginitis has existed, and there is agglutination or organic union of the tendon to its sheath, exsection of the sheath is the proper procedure. After exsection the tendon should be surrounded or covered with a layer of connective tissue, with as much of the fatty tissue as can possibly be secured; or the aponeurosis of a muscle may be turned over, or turned upward or downward, so as to cover the tendon and protect it from union to fixed bony prominences, immovable and inelastic ligaments or adhesions to the skin. In connection with the knee and elbow, this procedure is of great importance in securing a rapid restoration of function. Cicatrices, either from phlegmon or burns, should be extensively dissected and their places supplemented by large cutaneous flaps, with much of the fatty tissue attached. Area

flaps that are transplanted enlarge about one-third of the original size later if they are subjected to pressure or traction. After transplantation, beyond one-third they do not enlarge; therefore, where there would appear to be tension at the time of transplantation, this tension would subside to one-third of the area of the original transplanted flap.

Ankylosis from adhesive synovitis with fixation of the capsule to the head and neck of the bone, with subsequent contraction and cicatrization of the capsule, promises excellent results, if the capsule be completely excised and with it the closely attached ligaments, the head and neck should then be surrounded by an aponeurosis or muscle to prevent the reformation of adhesions. The mere division of the capsule, without its exsection, does not tend to a favorable result, as it reunites and fixes the joint. It must be borne in mind, as a principle in all of these operations, that the joint in the operation, should permit of free motion, be free from severe tension on tendons, capsule, or ligaments. If there be great tension under anæsthesia, there will be pain and tension beyond the ability of the patient to tolerate, when the effect of the anæsthetic has subsided. In all of these operations liberation of articulation should be to the degree of easy flail motions, rather than to restricted, binding ball-and-socket joint types. In the knee where the capsule and periarticular tissues have been involved in pathological processes, the posterior hamstring tendons, and quadriceps and patella tendons, with the crucial ligaments are the only attachments that should be allowed to remain at the time of the operation. All of the other ligaments should be carefully dissected and removed and the flaps so arranged that they will not be reproduced. If the capsular ligaments of the joint alone be simply divided and a muscle or aponeurosis interposed, the union through this muscular aponeurosis will become so strong and firm before the joint admits of painless passive motion, that passive or active motion will be an impossibility.

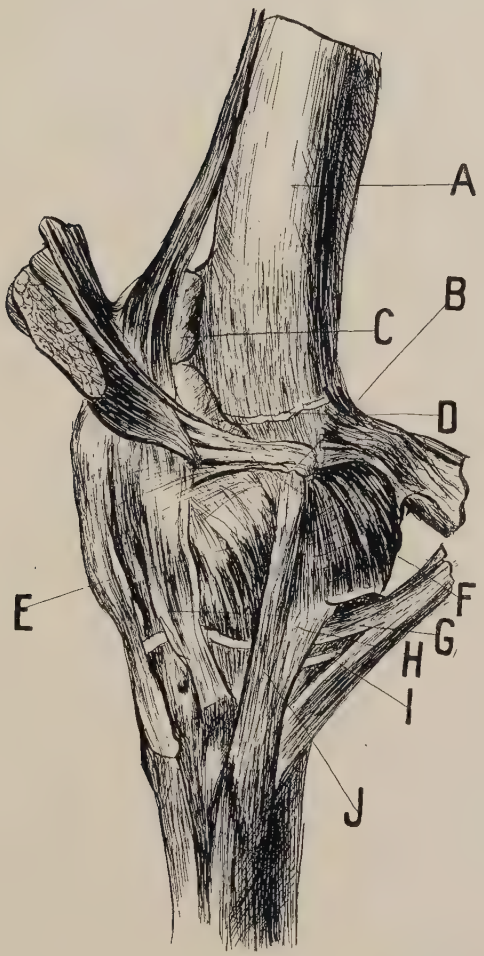
A point in arthroplasty is that flaps receive nutrition rapidly from the rich vascular supply to the ends of the bone. Being

made up (principally) of fatty and elastic fibrous-tissue elements which have but a slight vascularity, they receive nutriment to sustain their vitality by osmosis while a circulation is developing.

I believe that my early failures in production of motion in the knee-joint were due to the fact that I did not remove a sufficient portion of the lateral ligaments and capsule of the joint; in other words, that I did not free the tissues sufficiently to permit early, free, unrestricted motion. If the lateral ligaments of the knee be retained at all, they should be retained as a small band extending from the supreme point of the internal and external condyle to the internal and external tuberosities and not more than one-half an inch of this band should be left. (See Fig. 4, Toldt.) (Lateral ligament shown from point *B* to *J*.) This is the pivotal point in retention of the joint and the distance between these two points is not changed, no matter in what position the limb may be placed. It can be seen from the illustration (Fig. 5) that the synovial membrane extends well out on to the anatomical neck of the femur. In the shoulder the true capsule extends out to the major tubercle and completely surrounds the head of the humerus, as well as the glenoid cavity, and this capsule must be freed by a complete excision, if one hopes to get a movable joint from the interposition of aponeurosis or muscle. In the same manner, but to a more forcible degree, must the synovial membrane from *B* to *C* and *A* to *D* (Fig. 5) be removed, with the capsule as illustrated, if one hopes to get a movable hip-joint, without tension on the capsular ligament.

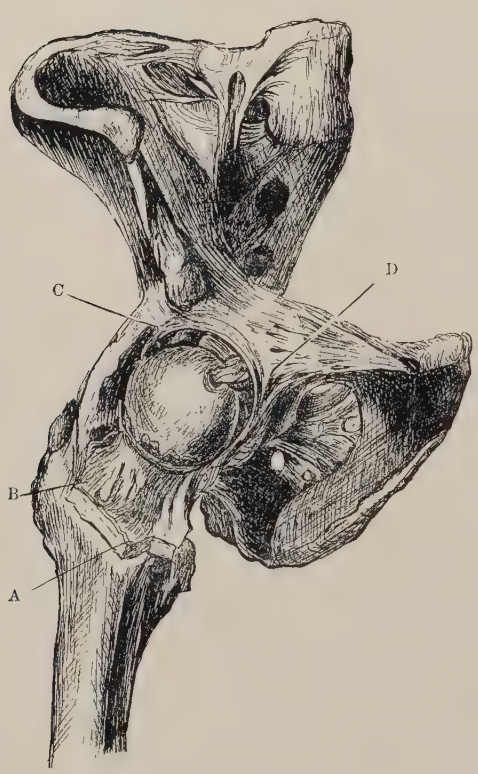
The same law governs the temporomaxillary and elbow-joints, but it requires more accurate skill and care to remove the capsule in the two latter than in the three former articulations. In all of these joints there are pivotal points of retention, and the tissues left attached must be so balanced as not to bring tension when the circumference of these pivotal points is put in motion; furthermore, the limbs must be hyperextended and abducted, as the adductor and flexor muscles are usually the ones that are contracted and the extensors and abductors are, as a rule, the weaker

FIG. 4.



The ligamentous band, extending from supreme point of inner condyle (B) to inner tuberosity (J) should be retained.

FIG. 5.



Interior of right hip-joint. The synovial membrane and capsule from B to C and A to D must be removed.

set of muscles. This weaker set should, therefore, be given the advantage in position of the limb immediately after operation. Tenotomy, myotomy, tendoplasty or myoplasty may be performed at the time of the operation. Great care must be taken, however, in operating on quadriceps or triceps tendons that the line of union is not permitted to adhere to the bone, as this would permanently incapacitate the muscle and prevent contraction. This can be readily avoided by interposing a flap of fatty tissue, muscle, or aponeurosis from the neighborhood.

In general, the elements which have contributed most to the failures have been:

1. The insufficient or defective exsection of the synovial membrane, capsule, and ligaments.

2. Insufficient interposition of fat and aponeurosis or of fat and muscle between the separated bony surfaces.

3. Infection.

4. Sensitiveness to pain in motion after operation.

Where osseous union has existed it is important to disconnect the bones in as nearly their normal line of union as possible. This can be done with the narrow chisel, better than with the saw. In the shoulder and hip, the chisel can be used to separate the bones and outline the line of fracture as deep as is necessary to secure the normal conformation, both of the head and cavity. All bony prominences that may impinge against other bones in extreme degrees of motion should be removed, as, for example, the coronoid and the tip of the olecranon process. The soft parts should be liberated most thoroughly. It appears a repetition but it cannot be too forcefully impressed upon the operator that this is essential to a good result, and also that muscular aponeurosis with fat makes the best interposed tissue. If the aponeurosis is not available, then the muscle and some fatty tissue should be substituted, as the muscle when subjected to pressure in a joint gradually flattens out into an aponeurosis, but it does not well withstand the early pressure to which it is subjected.

The development of a hygroma from pressure of fatty tissue

should be the uniform result, as was shown in experiment No. 1, and as occurred so perfectly in my first hip case. Where the muscular contraction is great it may be overcome by Buck's extension. So much for the general consideration of the operative technique. Now to the individual joints.

The temporomaxillary ankylosis was the first to attract the surgeon to this type of surgical intervention. Its results have so far been mostly the fibrous union type, but by using the temporal fascia and fat which can be readily interposed on the cadaver, movable and perfect joints should be produced on the living subject. The head of the bone should be excised where there is cicatricial contraction of the cheek muscles and fascia, as after a severe trauma. If much cicatricial tissue exists on the mucous side a flap of skin from the neck with its pedicle below the ear can be passed into the mouth, and the skin kept toward the teeth. The skin acts as a good substitute for the mucosa and excellent motion can be secured, as in a case I operated in this manner in 1898 at my clinic. The result is good to the present time. (I will not go into the details of operative technique here as they are given in full with the history of the individual cases that follows.)

Cases I. and II.—Mr. W. D., aged twenty-one years; occupation, barber; admitted to Mercy Hospital July 9, 1901.

Present illness began in November, 1900, with high fever and very severe pain in lumbar region of back. Shortly after onset the trouble extended to the hip, wrist and shoulder-joints of both sides and the two latter were swollen and tender to pressure. He was confined to bed for six months from the beginning of the trouble and during the first few weeks his temperature was high, several times reaching 105°. About one month after the onset, his right knee became affected and a few days later the left knee. Both joints were swollen and very painful for four months, and during this time they were kept absolutely at rest in full extension and he made no effort to move them. When the inflammatory process subsided, both knees were found to be stiff and this

condition has persisted until the present time. Shortly after getting out of bed he began to walk with the aid of crutches and has been obliged to continue their use ever since, because of the severe pain in the knees when his full weight is thrown upon them. The trouble in the other joints subsided without ankylosis. General health good at the present time.

Previous Illness. Fractured his right leg when fifteen years of age. No trouble from this source afterward. Two months before onset of present illness he contracted an acute gonorrhœa, which persisted for about two weeks. No history of syphilis. No injury to knees. Family history negative.

Examination. Medium stature. Well nourished. Heart, lungs, and abdomen negative. Both knee-joints are ankylosed in full extension and permit of no active or passive motion. Attempts at passive motion are very painful. Both patellæ are firmly ankylosed to femur.

On July 31, 1901, the patient was anæsthetized and the adhesions in both knees broken up by forcible manipulations. Passive motions were practised daily after this, but were attended by so much pain that they had to be discontinued after a short time. The adhesions rapidly reformed and the joints soon became as stiff as ever.

Second operation October 5, 1901.

1. Usual preparations. Esmarch's constrictor around thigh.

2. Vertical incision over outer side of right knee, from six inches above to three inches below joint. Incision deepened and capsule of joint opened.

3. Patella freed on outer side from fibrous adhesions to femur with scalpel and chisel.

4. A second vertical incision, 4 inches long made over inner side of joint. Joint opened. Patella freed on its inner side from the articular surface of the femur. Ligamentum patellæ not divided. Patella elevated.

5. Knee flexed and the adhesions between tibia and femur divided to give free motion in joint.

6. Large flap of fascia lata, with a thin layer of muscle tissue

attached, dissected from outer surface of vastus externus, its base being below and anterior. Flap then turned over the outer condyle of femur and drawn through the joint between the two bones (Fig. 6) by means of heavy catgut sutures, previously passed through its free edge and also through the fibrous capsule on the inner side of the joint. Sutures tied in inner incision. (Fig. 7.)

7. Small flap of fascia covering vastus internus dissected free in like manner and placed between patella and femur. Flap secured to capsule with catgut sutures.

8. Esmarch bandage removed and bleeding points secured.

9. Subcuticular catgut suture to close skin wounds. Small drain left in upper angle of external wound.

10. Dressing and bandages.

11. Knee immobilized in full extension by means of a posterior moulded cast of plaster of Paris.

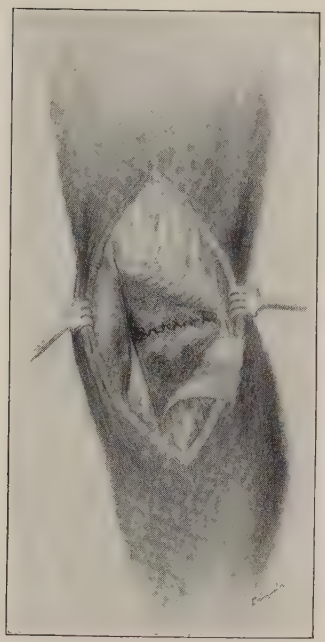
Convalescence after operation was uneventful and wounds healed by primary union. Cast was discontinued after three weeks. Joint was massaged and put through passive motions each day after the first week. On November 13th he was again anæsthetized and the knee forcibly flexed and extended several times. After November 21st he was allowed out of bed every day and encouraged to move the joint as much as possible.

Third operation on the other (left) knee, February 22, 1902. Usual preparation. Esmarch constrictor applied and rubber dam placed around knee. Incision eight inches long made on outer surface of left knee directly over external condyle and extending five inches above and three inches below the knee-joint. Incision carried down through the capsule into joint. Tissues retracted. Patella and femur found united by bony ankylosis. External condyle of femur and articular surface of tibia also united by bony union. Patella now chiselled free from femur, the ligamentum patellæ divided and the patella thrown upward. In the knee-joint the ankylosis was broken up with chisel and mallet and enough bony tissues removed from border of joint to allow of free motion. Second incision six inches long made over inner

Fig. 6.

Case I.—The fascial flap, with its pedicle below, has been turned into the knee-joint.

Fig. 7.



Case I.—Edge of flap sutured to joint capsule in inner incision.

Fig. 8.

Case I.—Showing degree of flexion in right knee after operation.

Fig. 9.

Case I.—Radiograph of right knee after operation. The clear spaces between the bones show that ankylosis has not recurred.

condyle, extending equal distances above and below joint. Capsular ligament divided. A flap of the fascia lata with pedicle attached just above the knee-joint taken from surface of vastus internus, turned in between the denuded ends of the tibia and femur, and its free edge sutured to the crucial ligament. On the outer side a similar, but larger, flap of fascia lata was dissected up from the vastus externus, drawn downward and inward under the patella to cover its posterior surface and then backward to cover the articular surface of the external condyle. Flap secured to capsular ligament by interrupted catgut sutures. Ligamentum patellæ reunited with kangaroo tendon sutures. Wound closed with buried catgut sutures in deep tissues and horse-hair for the skin. A forty-eight-hour drain inserted to allow the escape of blood. Straight posterior splint applied.

For sixteen days after operation the afternoon temperature ranged between 100° and 102°, and at times he complained of considerable pain in knee. On March 1st, the wound was dressed and a small quantity of serosanguineous fluid escaped from lower angle. There was no redness of skin and no evidence of infection. After March 10th the temperature remained normal permanently and pain rapidly subsided. Cast was removed March 19th and daily passive motions begun. On March 20th he was allowed out of bed in wheel-chair and began to walk with the aid of crutches on April 8th. April 12th he was anæsthetized and both knees flexed through an angle of 30°. Both patellæ were freely movable and motion in joints was quite free. Patient was put to bed for twenty-four hours and hot fomentations applied to knees. On June 5th this procedure was repeated.

On August 27th he was again anæsthetized and the right knee forcibly flexed several times. The motion in the left knee was not so free as in the right, the limitation apparently being due to thickening and contraction of the internal lateral ligament and adhesion of patella to the inner scar. The internal lateral ligament was divided with a long, narrow-bladed scalpel and the same instrument used to separate the patella from scar. The incision in the skin was just large enough to admit the blade of the knife.

The joint was then forcibly flexed several times until motion was perfectly free. After three days he was allowed to get up and walk with the assistance of a cane. On October 30th both knees were again put through passive motions under anæsthesia. Patient left the hospital December 4, 1902. At that time he was able to walk without cane or crutch, had motion in both knees to the extent of between ten and fifteen degrees and both patellæ were perfectly free. (See Fig. 8.)

In a report received from this patient June 23, 1904, he states that he works at his occupation every day and is on his feet continuously for twelve hours each day. There is no swelling in the knees and he has no pain. After being on his feet for twelve or fourteen hours there is some soreness in the knees, but this disappears during the night. He walks without cane or crutch. He says the motion in right knee amounts to about three or four inches and in the left to about one inch. (See Fig. 9.)

Case III.—Mr. J. H. M., aged thirty-eight years; occupation, contractor; admitted to Cook County Hospital October 30, 1901.

Present Illness. One year ago patient was shot three times, one of the bullets taking effect in the inner side of the left thigh, another in the left side of the chest and the third over the left patella. The physician who attended him said that the patella was not fractured, but that the bullet passed through the knee-joint and lodged beneath the skin under the inner tuberosity of the tibia, from which place it was removed seventeen days afterward. The patient says there was no suppuration in any of the wounds, but he had severe pain in the knee-joint and it was extremely tender to pressure. After removal of the bullet the limb was put in a plaster cast with knee extended and the cast left on for about five weeks. When it was removed the physician discovered "some outward rotation of the leg," so the patient was anæsthetized and the joint put through passive motions. Another cast was applied and left on for one month. When this one was removed, the leg was stiff and has remained so ever since. At present the patient complains of stiffness in the knee, "coldness of the leg" below the knee and some numbness over the inner

side of the leg. He has had no severe pain at any time, but complains of weakness in the knee.

Examination. Slight swelling about the left knee-joint. Firm ankylosis of the patella to the articular surface of the femur and also between tibia and femur. No irregularity in the shape of the patella. Partial anæsthesia of skin over the inner side of left calf. Scars at position of entrance of bullet and at site of removal.

Operation, November 1, 1901. Vertical incision six inches long over inner side of left knee-joint down to the bone. Patella liberated from inner condyle of femur through line of osseous union, by means of chisel and mallet. Second incision on outer side of joint near the outer border of the patella. Liberation of patelal completed, ligamentum patellæ divided, and the bony union between tibia and femur separated with the chisel. The incision on the inner side now extended upward and a flap of the fascia lata covering the vastus internus dissected free with the pedicle attached below. This flap was then turned into the joint between the tibia and femur and its anterior portion interposed between the patella and the condyles of the femur. The free border of the flap was sutured with catgut to the capsule of the joint on the posterior, outer, and anterior sides, to prevent its subsequent displacement, and the edges of the divided capsule were approximated with catgut sutures. The superficial wounds were closed with silkworm-gut, dry dressing applied and the entire lower extremity immobilized with the knee-joint extended, in a posterior plaster cast. No drain. (This was an error considering the extensive dissection necessary in this operation and the subsequent oozing that takes place from the bone.)

After the operation, infection of the wound occurred and he had a temperature ranging from 100° to 104° until November 14th. After that date the temperature was lower, but did not reach normal until February 12, 1902. Suppuration did not set in until eight days after the operation, when the removal of a few sutures allowed a considerable quantity of seropurulent material to escape. The exact cause of the infection was unknown, but

in all probability it was due to some error in the preparation of the dressing material or catgut. February 18, 1902, there was still slight discharge from the wound where the drainage tube had been inserted at the time suppuration developed. Slight motion was present in the knee-joint, but the large amount of fibrous tissue which had formed, as a result of the suppuration, prevented more than about two degrees of flexion. There was no return of the bony ankylosis notwithstanding the suppuration. (We have been unable to locate this patient since February 18, 1902.)

Case IV.—Master J. A., Marysville, Washington; aged twelve years; school-boy; admitted to Mercy Hospital July 24, 1902. Family and previous history negative.

Present Illness. On December 26, 1900, patient was shot in the abdomen, two inches below the navel, with a 0.22 calibre gun. The gun was directly in front of him, and about twelve feet distant. There was no wound of exit. Operation was performed at once by Dr. W. C. Cox, of Everett, Washington, and ten perforations of the intestine sutured. Recovery from operation was good. While in bed he complained of great pain in the right hip, knee, and ankle, and on this account he was allowed to lie with his knee flexed at an acute angle and the thigh at a right angle to the body. The hip gradually became ankylosed in this position and has remained so to the present time. He still has considerable pain in the right knee and ankle. A small sinus at the lower end of the abdominal incision has never healed and a slight purulent discharge from it has continued. No gas or fecal matter has been noticed. When he was allowed out of bed he found that he had no use of the right leg and thigh, both of which were flexed at right angles. In March, 1901, the pain became less severe in the hip-joint and forcible extension was attempted, but found to be impossible. In October, 1901, the bullet was passed from the bowel, evidently having ulcerated into it from its place of lodgement. For the past year the patient has been able to walk only with the aid of crutches.

Examination. Poorly nourished boy. Temperature, 99.4°. Heart and lungs negative. Abdomen: Small sinus at lower end

of incision, discharging a small amount of pus. Probe inserted into right pelvic fossa and dead bone detected. Some resistance in the right iliac region. Right thigh flexed on abdomen at nearly a right angle, abducted five degrees and firmly ankylosed. No motion exists in hip-joint and attempts at passive motion are painful. Thigh is atrophied. Spine normal.

First operation, July 26, 1902. Probe inserted through sinus down to bottom, dead bone found. Incision over the right iliac crest four inches long; periosteum on inner surface of ilium dissected upward for five inches in the direction of the sinus. When sinus was reached the periosteum and peritoneum were retracted upward and inward, exposing the opening into the acetabular cavity. This opening was enlarged with the chisel and mallet and a small piece of dead bone removed. The acetabular cavity was drained with a strip of gauze, periosteum and peritoneum allowed to fall back in place and the external wound closed with interrupted silkworm-gut sutures. Some discharge persisted after the operation and the wound was not healed when the patient left the hospital August 25, 1902.

The patient re-entered the hospital September 30, 1902, with both sinuses still open and discharging a small quantity of pus. The sinuses were irrigated every other day with hydrogen peroxide and on the alternate days with a solution of bisulphate of quinine. He was also given *x*-ray treatments to the right lower abdomen and hip every other day.

Second operation, November 29, 1902. The probe was passed through the original sinus in the median line down to the acetabulum. The acetabular cavity was curetted out thoroughly and a perforated rubber tube inserted for drainage. At this time the outer wound had completely healed. After operation the patient had slight elevation of temperature for three days, after which it remained practically normal. The sinus was irrigated with hydrogen peroxide every other day and *x*-ray treatments continued. Some discharge persisted after the tube was removed.

Third operation, February 11, 1903. Incision two and one-half inches long through outer margin of right rectus muscle, external

to sinus. Peritoneal cavity opened and intestines displaced upward out of the field by means of lap pads and coffer dams of iodoform gauze. After the field was thoroughly prepared and the general peritoneal cavity carefully protected, the opening into the acetabulum was located from the peritoneal side and enlarged directly through the posterior parietal peritoneum.

Examination of the interior of the cavity showed the necrotic head of the femur lying free within. The opening was further enlarged with the chisel and the necrotic head extracted entire. The granulation tissue lining of the cavity was then curetted out, and a drainage tube inserted through the old sinus into the acetabular cavity. This sinus proved to be extraperitoneal and passed internal to the external iliac and external to the internal iliac vessels and ureter. The opening in the posterior peritoneum was closed with catgut sutures, the coffer dams and pads removed, and the anterior incision closed in the usual way by uniting the separate layers of the abdominal wall with buried catgut sutures. No drainage of the peritoneal cavity was used.

After operation the temperature ranged between 99° and 102° until February 17th, after which date it remained normal during the rest of his stay in the hospital, except for a transitory rise on February 23d. Sutures were removed on the tenth day and the tube removed from sinus on the fourteenth day. The patient sat up in chair for first time February 19th, after which he was out of bed every day.

On March 24th the sinus closed completely and permanently. A skiagraph of hip taken April 25, 1903, shows that there was complete bony union between the neck of the femur and the ilium. (See Fig. 10.)

Fourth operation (for relief of ankylosis), May 2, 1903. Usual aseptic preparation of right hip and thigh. Rubber dam applied over hip surrounding trochanter on all sides. A U-shaped incision five inches wide with its base upward was made, beginning four inches above the trochanter and extending downward two inches below it. The trochanter was exactly in the centre of the U. The incision was through the skin, superficial fascia, and

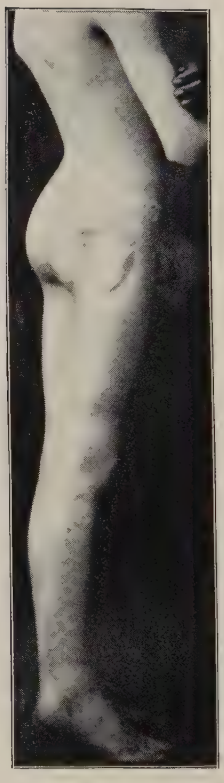
Fig. 10.

Case IV.—Radiograph of right hip before operation, showing bony union between neck of femur and ilium.

Fig. 11.

Case IV.—Photograph taken one year after operation. Shows normal degree of active flexion.

Fig. 12.



Case IV.—Photograph taken one year after operation. Shows normal degree of extension with one and one-half inch shortening.

fascia lata and these tissues were dissected upward as one flap. A long curved needle, threaded with heavy silk, was now passed around the base of the trochanter, beneath the muscles attached to it, and by means of this carrier a chain-saw was brought into position. The trochanter was then sawn off and thrown upward. The capsule of the joint was next incised and separated from the ilium all the way around. The attachment of the gluteus maximus was not disturbed.

The bone was examined and the neck of the femur found to be continuous with the margin of the acetabulum by firm bony union. The formation of a new head for the femur and a new acetabular cavity was the next step in the operation and was accomplished in the following manner: The bony tissue filling the acetabulum was chiselled free from the latter by following around its margin, the line of junction with the neck, with a curved carpenter's chisel one and one-half inches in diameter. The chisel each time was driven in obliquely toward the fossa acetabuli, the object of this being to make the new femoral head as nearly spherical as possible. When the chiselling process was completed the new head was entirely separated from the sides of the acetabulum and attached only at the bottom by a narrow bridge of bone. This bridge was fractured by forcible abduction of the limb, after which the head was dislocated from the cavity and brought out of it by external rotation of the thigh. Its shape and contour were almost exactly those of a normal femoral head, except for a few sharp, bony projections, which were removed by means of a bone-cutting forceps. Examination of the acetabulum showed that the opening at the bottom, through which the necrotic bone had been removed was entirely closed by a deposit of new bone. A curette was used to smooth off the irregularities produced by the chisel and to enlarge the cavity. The fascia lata which formed a part of the original U-shaped flap was now dissected away from the subcutaneous fatty tissue down to its base, where the vessels entered to supply it with blood. The flap of fascia was then drawn down under the head of the femur and carefully fitted into the acetabular cavity to form a complete lining for it. The under surface of the

flap, one-half inch from the edge, was sutured to the joint capsule around the acetabular margin with interrupted catgut sutures, to secure it and prevent its displacement subsequently.

The new socket being in readiness, the head of the femur was returned to its normal position by extension and adduction of the thigh. It was found to fit accurately and could not be dislocated by any of the ordinary motions of moderate degree. The free border of the fascial flap which projected from the margin of the acetabulum was now sutured with interrupted catgut sutures to the periosteum and capsule attached to the neck of the femur. The flap was amply large, so that it completely covered the head and came well up on to the neck without tension. (I consider this a very important point; the entire articular surfaces of the bones must be covered by fascia if we are to expect a good functional result and the same applies to other joints as well as to the hip.) The great trochanter was brought down to its normal position and accurately secured to the femur with two aluminum-bronze wire sutures. The skin flap was replaced and sutured with horse-hair. No drainage was used. Because of the contraction of the flexors and adductors of the thigh, extension and abduction were limited and accomplished only by the use of considerable force. This contraction was overcome by forcibly stretching the muscles, using the thigh as a lever and at the same time exerting with the edge of the hand strong pressure, combined with a sawing motion, over them near their points of origin, after the Lorenz method. The sartorius was divided with the scalpel close to its attachment to the anterior superior spine. To retain the limb immobilized until firm union of the parts was secured, a plaster cast was applied, including the pelvis and entire limb in full extension and abduction.

The patient was put to bed and a Buck extension with a ten-pound weight applied to right leg. The temperature was normal until the afternoon of May 6th, when it went up to 101°. From May 6th to May 25th the afternoon temperature registered between 99° and 100°, usually 99.5°. During this time he was quite comfortable, but occasionally complained of pain in the hip.

On May 12th a window was cut in the cast over the great trochanter and wound examined. It was found to be healed by primary union. The dressings were moist over the lower portion of the incision with a small amount of serous discharge which contained globules of fat. Passive rotation of the thigh caused less pain than it had four days previously. On May 14th the wound was again exposed and sutures removed. No redness of skin and only slight tenderness was found. A small amount of serosanguineous fluid was expressed from the lower end of the incision. Dry dressings applied. On May 20th the cast was removed and examination showed great freedom of motion in the hip-joint. After June 13th, the Buck extension was removed during the day, but kept on at night. The patient was allowed to get up in a wheel-chair on June 14th. He walked for the first time with the aid of crutches on June 22d, and continued to walk each day after that. On July 8th it was noted that freedom of motion was increasing every day. On July 11th, the examination showed the hip-joint allowed of fully 20 per cent. of the normal amount of rotation and 20 to 30 per cent. of the normal amount of flexion and extension. The patient left the hospital July 18, 1903.

In a letter received from his father May 20, 1904, with which he sent three photographs showing the range of motion in hip, he stated that the patient went to school every day and had not used a cane or crutch for several months. The motion in hip is free and of normal extent, and he has absolutely no pain at any time. The photographs (see Figs. 11 and 12) show flexion and extension to be normal. There is about one and three-quarter inches' shortening in the limb, and he wears an elevated sole to compensate for this.

Case V.—Miss M. S., aged twenty-six years; dressmaker; admitted to Mercy Hospital May 2, 1903. Family and previous history negative.

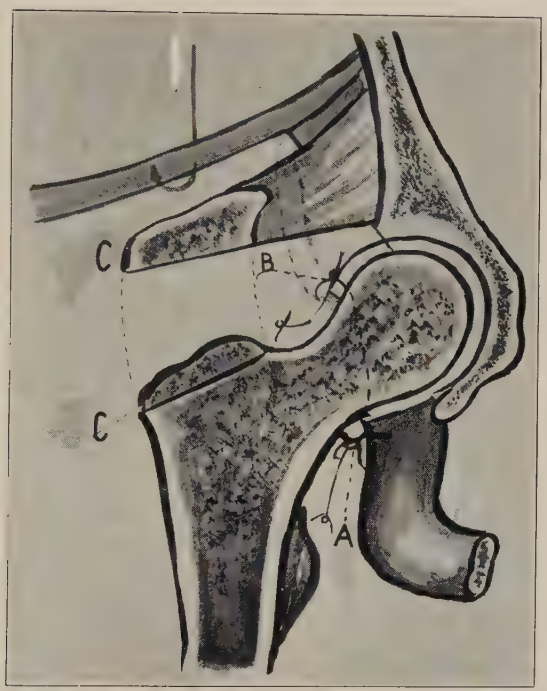
Present illness began eight years ago with an acute inflammatory process in the right hip-joint. At that time the slightest active or passive motion was very painful and the region of the joint was extremely tender to pressure. She does not remember that

it was swollen. When the trouble came on she went to bed and was unable to get up for two or three days. After that the intense pain subsided and she was up most of the time, though occasionally would be confined to bed for a few days. The trouble continued about the same for nine months and during which time she walked very little without the assistance of a cane or crutch, because of the pain in the hip when she attempted to do so. As the trouble gradually subsided she noticed that the hip was stiff and she could flex the thigh only to a very limited extent. The immobility of the joint gradually became absolute and at the present time there is no motion at all. Nearly two years ago the same trouble developed in the left hip, but the progress of the disease was more gradual and she has at no time been confined to bed. Since two or three months ago she has noticed some stiffness in the left hip, but there is still considerable motion in it. The use of the limb, however, is accompanied by pain. No other joints have been involved at any time. Her general health has been good; appetite fair; has lost in weight.

Examination. Fairly well-nourished woman; heart, lungs and abdomen negative. Right lower extremity is in full extension and adducted beyond the middle line, with absolutely no motion in hip-joint; all passive motions of the thigh carry the pelvis with the femur as though the two were one bone. Some tenderness in joint on pressure over the great trochanter. Trochanter in normal position. Muscles of the thigh are somewhat atrophied. Examination of left hip shows a slight degree of motion present, but very painful. The limb is extended and adducted so that the knees are pressed together. There is extreme tenderness on pressure over the left great trochanter and around the margin of the joint. Afternoon temperature is usually slightly elevated to 99° and 99.6°.

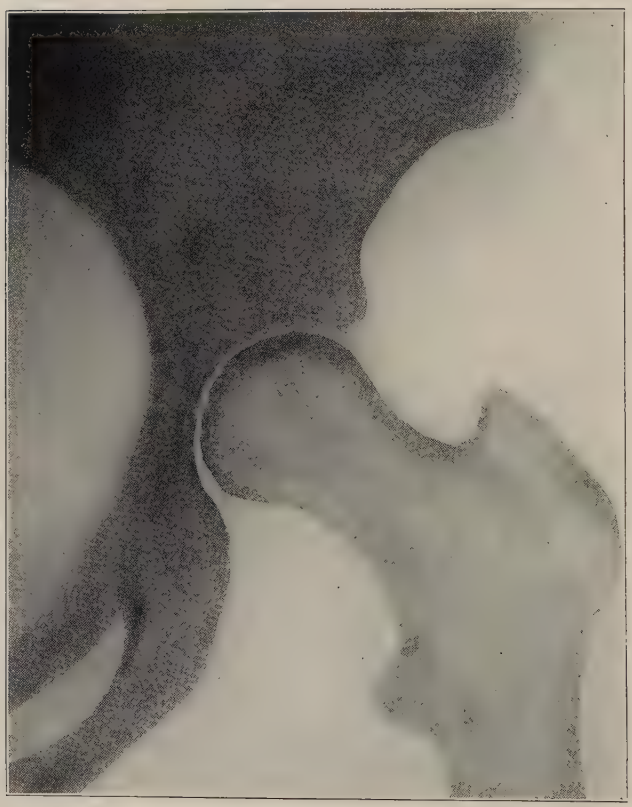
Operation, May 21, 1903. A U-shaped incision was made on the outer surface of the right hip, with its base upward and just above the level of the great trochanter, the latter being in the centre of the U. The limbs of the incision were five inches apart and each limb about five inches long; in depth it extended through

FIG. 13.



CASE V.—Great trochanter (*C*) with its attached muscles turned upward. The fascial flap surrounds the head of the femur and is sutured to the capsule at *A* and *B*

Fig. 14.



Case V.—Radiograph of right hip after operation, showing free-joint cavity.

the fascia lata. The skin, subcutaneous fat and fascia lata, embraced in the U, were dissected upward as a flap. A chain-saw was passed around the great trochanter by means of a silk carrier now threaded on a long, curved needle and the trochanter divided at its base from the femur. The trochanter with its attached muscles was turned upward (see Fig. 13) exposing the head of the femur in the bottom of the wound. The head was found to be firmly united to the acetabulum by bony ankylosis, so that they formed practically one bone. They were separated from each other with a large, curved carpenter's chisel and the surfaces smoothed with curette and bone-cutting forceps. The fascia lata was then separated from the skin flap down to its base, where it received its blood supply, and turned in between the new head of the femur and the bottom of the acetabular cavity. It was accurately fitted into the cavity so as to form a complete lining for it, and sutured to the capsule around the margin of the acetabulum, with heavy, interrupted catgut sutures. Only the proximal portion of the flap was used to line the cavity and after it was sutured in place, the head of the femur was replaced in the acetabulum. The distal portion was sutured around and completely encircled the neck out to the trochanter. The great trochanter was now brought down and secured in normal position on femur with aluminum-bronze wire. The skin flap was replaced and the wound closed with horse-hair. The limb was immobilized in full extension by placing it in a plaster-of-Paris cast, which surrounded the lower portion of the body and the entire right lower extremity. The patient returned to bed and a Buck extension applied. (I believe a better result would have been obtained if the limb had been dressed in a very abducted position.)

After operation the afternoon temperature ranged from 100° to 103°, until May 30th, when it began to subside. During this time she was fairly comfortable, but occasionally complained of pain in the hip and across the pelvis. Six days after the operation a window was cut in the cast and the wound examined. There was some swelling and redness of the flap and a grooved director passed between the sutured wound allowed a quantity of turbid,

serous fluid to escape. From June 1st to July 11th her temperature was slightly elevated in the afternoon, usually registering 99.5° to 100°. During this time there was a slight seropurulent discharge from the lower portion of the wound. On June 8th, a small tube was inserted in the upper angle as the drainage was not free; hot wet dressings applied. The sutures were removed on June 17th and the cast taken off June 18th. From July 11th to July 26th her temperature was approximately normal all day. On July 22d the small tube was removed from the wound. On July 27th the left knee became swollen, tender and very painful and her temperature went up to 101°. The pain and swelling continued until August 7th, but the temperature remained high for two days only, when it again became practically normal and remained so until September 8th. On August 7th the marked tendency to adduction of the limbs which had been present was overcome by placing a wedge between the knees and widening it each day until they were separated about eighteen inches. The Buck extension remained in place until August 8th, when it was removed.

Examination August 8th showed slight motion in right hip-joint and considerable atrophy of the muscles of the right leg and thigh. (See Fig. 14.) Faradic electricity and massage of thigh and leg were ordered daily. The patient was allowed out of bed August 15th and was around in a wheel-chair every day after that. From September 8th to the 25th her temperature was irregular, registering from 99° to 100.6° in the afternoon. This was probably due to the arthritis in the left hip and knee, not operated.

From September 25th until her discharge from the hospital, temperature was normal. The patient walked for the first time with the aid of crutches on December 7th and was on her feet every day after that date. She left the hospital February 15, 1904. At that time the wound was entirely healed and there was free motion in the right hip-joint. The patient was very sensitive to pain and would make no effort to move the joint herself or to bear any weight on it.

Examination June 3, 1904, showed the following conditions:

The patient is able to rotate entire lower extremity from hip to the extent of thirty degrees. The arc described by great toe during rotation is used as a measurement. When she stands erect on the left leg with pelvis fixed, she can move the right foot forward eighteen inches in front of plumb line from left hip-joint and the same distance posterior to it. She is able to bear her entire weight on the right lower limb without pain, but always uses crutches in walking. She has made no attempt at any time since the operation to dispense with the crutches, because of fear of pain and injury to the hip. When lying flat on her back she can elevate the lower extremity (right) to the extent of raising heel two inches above level of the table without pain. The wound is at present entirely healed. Two weeks ago it opened at site of old sinus and a small piece of bone was discharged. The muscles of thigh are atrophied from non-use. The muscular contraction is quite pronounced in this case, particularly the adductors. (In the future when operating on the hip I will dress them in extreme abduction with extension.)

Case VI.—M. L., aged nine years; school-girl; admitted to Mercy Hospital August 26, 1903. Family history negative. Previous history: "Measles" four years ago; "whooping cough" one year ago.

Present Illness. Five years ago while at play, patient fell, striking on her left knee. She did not complain much at the time, but two days later began to have pain in the knee and fever and a slight swelling developed above the patella. The swelling increased rapidly during the first few days and at the end of three weeks it was lanced on the anteroexternal surface of the limb a little below the knee. No pus was found but the wound did not heal and shortly after operation it began to discharge a watery secretion, which continued for two months. At the onset of the trouble the knee was bandaged in a flexed position and no attempt was made subsequently to straighten it. The result was that it became ankylosed at a right angle. Two years ago she was placed under an anæsthetic and the leg forcibly extended on the thigh. A plaster cast was applied and worn for about one year.

When the cast was removed the leg was flexed at an angle of twenty degrees, but the flexion gradually increased until at the present time it is again at a right angle. General health has remained good all of the time.

First operation, August 29, 1903. Vertical incision three and one-half inches long over the outer hamstring tendon on the posterior surface of the joint. All of the tendons were elongated by the ordinary method of tendoplasty and the ends united with fine kangaroo tendon. The leg was then extended by forcible manipulation, but it was necessary to divide the fascia posterior to the joint in order to secure complete extension. The adhesions between the tibia and femur were fibrous and allowed of slight passive motion under the anæsthetic. As is usually the case, after prolonged ankylosis of the knee at a right angle, there was subluxation of the tibia posteriorly. (Fig. 15.) Wound closed with buried catgut sutures in the deep tissues and horse-hair for the skin. For five days after the operation the patient had some evening temperature, ranging from 99° to 100.5°. Wound healed by primary union.

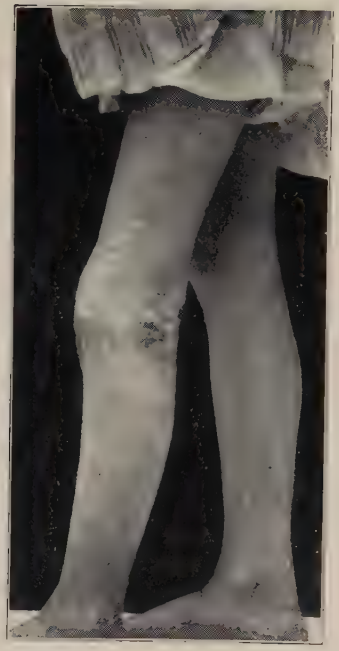
Second operation, September 14, 1903. A U-shaped incision six inches long was made, beginning just above and to the inner side of the patella, extending downward below it, and then upward on its outer side. The ligamentum patellæ and lateral ligaments of the knee-joint were divided and the patella turned upward.

Examination of the joint showed the following conditions: The synovial membrane lining the upper anterior diverticulum and that covering the outer condyle of the femur was destroyed by the process and there were two or three small foci of ancient suppuration in the head of the tibia on the outer side. Fibrous adhesions existed between the outer condyle and the tibia. The small foci were removed from the articular surface of the tibia with the curette and the adhesions between the bones broken up by forcible manipulation. A flap of the fascia lata and adipose tissue with its pedicle below was then dissected from the vastus externus, turned in between the outer condyle of the femur and the articular surface of the tibia and its free edge sutured to the

FIG. 15.

CASE VI. — Radiograph of left knee before operation, showing posterior subluxation of tibia and union between bones.

FIG. 16.



CASE VI. — Photograph after operation. Shows the knee extended and posterior subluxation reduced.

FIG. 17.

CASE VI.—Radiograph of left knee nine months after operation. Shows separation of bones and perfect reduction of subluxation. Patella free.

capsule of the joint. The ligamentum patellæ was united with catgut and the skin approximated with horse-hair. A posterior splint applied, immobilizing knee in full extension.

After operation, patient's temperature ranged between 100° and 104°, with pulse 130 to 150, until September 19th, when both gradually became lower. On September 28th the sutures were removed and the wound found to have healed by primary union. On the 29th her temperature again went up to 102° and pulse to 140. This persisted for five days, after which the temperature was only slightly elevated in the evening. On October 17th there was slight discharge from lower end of the inner incision. *x*-ray treatment, fifteen minutes each day, ordered for its stimulating effect. From October 23d until patient's discharge from hospital her temperature was normal, both A.M. and P.M. On October 28th a small pus accumulation in popliteal space was opened and several drachms of pus evacuated. Patient left the hospital November 30, 1903. (See Fig. 16.)

From the time of the patient's discharge from hospital to June 2, 1904, she did not report for examination or treatment, so that the important post-operative treatment was neglected. On June 2, 1904, she presented herself at the office for examination. Since leaving the hospital she had worn constantly an anterior cast of plaster of Paris, extending from groin to ankle and immobilizing the knee in full extension. No attempt had been made by the patient or others to increase the motion in the joint. There was a small sinus at the lower angle of inner incision, which discharged a small quantity of pus. A moderate amount of swelling existed about the knee anteriorly but there was no fluid beneath the patella and pressure over the joint was not painful. The muscles of the leg and thigh were somewhat atrophied from non-use. There was free and painless motion in the knee-joint, both active and passive, to the extent of between ten and fifteen degrees. The patella moved with the leg during flexion and extension, but permitted of no lateral motion. (See Fig. 17.) She was able to walk and run about all day without crutch or support of any kind and had no pain at any time, even after prolonged walking or standing.

The cast was removed and the patient told to exercise the limb and increase motion in the joint actively and passively.

Case VII.—Mr. H. C. C., aged twenty-three years; occupation, electrician; admitted to Mercy Hospital December 31, 1903.

Present Illness. In June, 1901, patient fell between two buildings and severely wrenched his left leg. Immediately following the accident he suffered great pain in the leg and thigh, but after a few hours was able to walk and go on with his work. Three days later he began to have pain in the left inguinal region. This pain persisted and a tender swelling finally developed in the left groin. The swelling was small at first and gradually enlarged until it attained the size of a hen's egg. On October 9th a physician incised it and evacuated a large quantity of pus. The abscess drained for nine months, when the sinus healed temporarily. It re-opened last July and continued to discharge until one week ago. After the abscess was drained the patient suffered very little pain, except while running or stooping forward, when he would have some pain in the left hip.

On December 16, 1902, he was taken sick with what was diagnosed "typhoid fever," and confined to bed for five weeks. Two days after getting out of bed he had a severe chill, followed by fever and sharp pain in the left hip and knee. He was again confined to bed for three months during which time the pain in the hip and knee continued very severe. While in bed, the thigh was flexed on abdomen, adducted and rotated inward, no attempt being made to correct this faulty position. When, therefore, after three months he attempted to straighten the limb he found it was impossible and it has remained in the same position up to the present time. He still has a great deal of pain in the hip and knee, especially when he attempts motion, and pressure over the joint is painful. General health not good; appetite poor and he cannot gain strength. Previous and family history negative.

Examination. Small stature; emaciated and anæmic; heart and lungs negative. Spine negative. Left thigh is flexed at a right angle on abdomen, rotated slightly inward and adducted beyond the middle line. All attempts at passive motion of hip are very

painful and pressure over the great trochanter causes great pain. No motion in the hip-joint can be demonstrated. The leg is flexed at a right angle to the thigh and the hamstring muscles so contracted that extension is impossible. No ankylosis exists, however, in the knee. (While this was not a favorable case for arthroplasty—as the tuberculosis was in the active stage—it was decided that the interposition of the fascia lata might hasten the repair of the tuberculous process, as aponeurotic tissue offers great resistance to this type of infection.)

Operation, January 11, 1904. A U-shaped incision, base upward, five inches long by four and one-half inches wide, was made over the left hip, through skin, subcutaneous fat and fascia lata. The trochanter major was in the centre of the U. Flap dissected from muscle. Great trochanter separated from femur with wire saw and turned upward. Joint opened by incision through capsule above and anteriorly.

Examination showed the head and adjacent portion of neck of femur destroyed by an acute tuberculosis. The acetabulum was a mass of granulation tissue. The diseased head was removed with bone-cutting forceps and the tuberculous foci in the neck curetted out. After all of the diseased tissue had been removed, there remained a stump of about one inch of the neck, acetabulum curetted. The fascia lata and adipose tissue which formed part of the original flap were now dissected from the skin, as far as the pedicle, turned down over the end of the neck and sutured to the circumference of the capsule, where it was reflected on to the trochanters. The great trochanter was then turned down and secured in its normal position with heavy kangaroo tendon. The femoral neck, entirely covered by the fascial flap, was next placed in the acetabulum, the edges of the capsule approximated with catgut and the limb forcibly extended and abducted to stretch the contracted muscles of hip and knee. When the thigh was fully extended and abducted, the end of the neck, or new femoral head, occupied a position beneath the prominent upper border of the acetabulum, which held it securely in place and prevented its dislocation upward. The skin incision was closed with silkworm

gut and a small rubber drainage tube inserted at the lower angle of the wound. The entire limb was immobilized in a hyperextended and slightly abducted position, by a plaster cast, which surrounded the pelvis and covered the anterior surface of the limb from the groin to the toes. The patient was put to bed and Buck's extension with fifteen pound weight applied to leg.

From January 11th to January 17th, temperature ranged from 99.2° to 101°, and at times he complained of considerable pain in the hip and knee. The skin wound healed by primary union. Sutures were removed January 25th and the drainage tube on January 27th. Buck's extension was taken off at the end of the third week. He began to walk with the aid of crutches on February 19th, but bore no weight on the operated limb until two weeks later. The cast was removed at the end of the sixth week and the hip and knee put through passive motions each day thereafter. On March 26th a small swelling above left Poupart's ligament was aspirated and several drachms of thick pus withdrawn; 10 c.c. of iodoform emulsion in glycerin were injected into the abscess cavity and the puncture sealed with collodion. The swelling rapidly diminished in size after the injection and the pain disappeared.

On April 6th the patient complained of pain and tenderness on inner side of left thigh and his temperature went up to 101.6°. Four days later a fluctuating swelling appeared about five inches below the inner end of Poupart's ligament. This was incised and several ounces of pus evacuated. Temperature then became normal and remained so until April 30th, when pus retention in the abscess caused a second elevation to 100.8°. A drainage tube was inserted and the temperature again became normal. Tube was removed in two weeks.

The patient left the hospital June 5th. At that time he could bear some weight on the limb without pain, but was obliged to use crutches in walking. Examination showed the great trochanter in normal position and the limb fully extended, though slightly adducted. The motion in the hip-joint, though very limited, was perfectly free, showing that no bony or fibrous union

had taken place between the neck of the femur and the ilium. (I am now convinced that the limitation of motion here, as in some of the earlier cases, was due to the fact that the capsule of the joint was not entirely removed.)

Case VIII.—Mr. Z., Bohemian, aged twenty-six years; admitted to Mercy Hospital April 19, 1904.

Present Illness. The patient does not speak English and it was impossible, therefore, to obtain a perfectly accurate history. Through an interpreter he stated that stiffness in the right elbow began to develop about ten years ago and progressed steadily until the joint was completely ankylosed at a right angle. He stated positively that there was no acute inflammation in the joint at any time before or after the beginning of the trouble and that he never injured the elbow. From his statements it would seem that the lesion was from the first an ankylosing arthritis. No other joints were involved at any time and his general health has been good. He gave no history of tuberculous or specific trouble and he never had pain in the elbow, arm, or forearm.

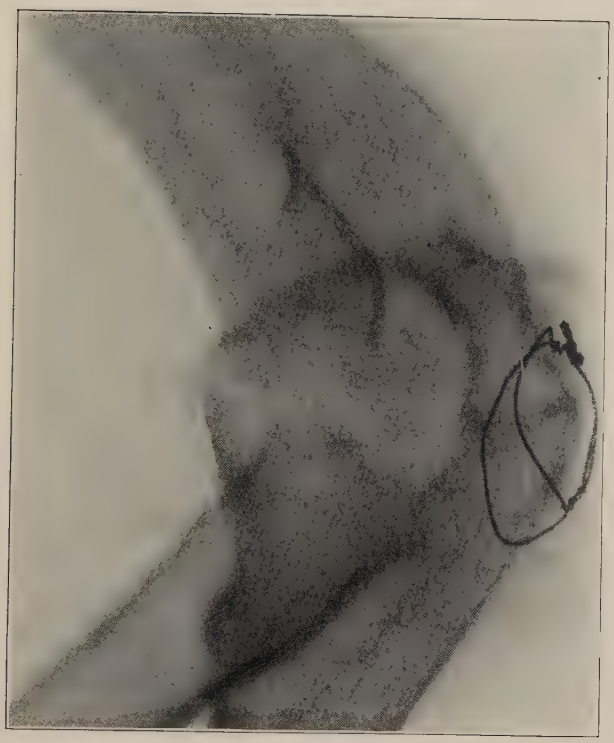
Examination. Medium stature, rather poor nourishment. Right forearm is flexed at a right angle and there is absolutely no motion in the elbow-joint. The muscles of the arm are atrophied to an extreme degree from non-use, as are also those of the forearm but to a lesser degree. No swelling exists about the elbow-joint, except over the articular surface of the radius, where the bone is somewhat thickened. The olecranon fossa is partly filled by bony deposit.

Operation, April 20, 1904. Esmarch's constrictor applied to the arm. A vertical incision, six inches long, was made on the posterior surface of the right elbow directly over the olecranon process. It extended from two inches below the tip of the process to four inches above it and exposed the surface of the olecranon and deep fascia, covering the triceps. The skin and subcutaneous fat were dissected laterally from the bone and fascia for one and one-half inches on each side of the incision and the edges of the wound widely retracted. A pyriform flap of the deep fascia was now dissected from the posterior surface of the triceps. The flap was

four and one-half inches long by two and one-half inches wide at its upper end and received its blood supply through a broad pedicle which remained attached to the muscle and fascia just below the level of the tip of the olecranon. By means of a long, curved needle, threaded with a heavy silk carrier, a wire saw was passed around the base of the olecranon and the latter severed from the ulna. The bone was sawed through in an oblique direction from within outward, in order to secure broad, bony surfaces for subsequent union. After separating with chisel and mallet the bony connection between the olecranon, and humerus, the former with triceps attachment undisturbed was retracted upward and the interior of the joint exposed. Examination showed firm, bony ankylosis which involved the entire elbow-joint. The synovial membrane and cartilage had been destroyed and not a vestige of them remained. The union was firmest between the external condyle and the head of the radius, where in addition to the osseous tissue connecting the articular surfaces, exostoses from the margin of the radial head surrounded the condyle.

The bony adhesion between the head of the radius and the lesser sigmoid cavity was separated with the chisel, the coronoid process liberated from the trochlea in the same manner and the bony deposit which filled the olecranon depression removed with the curette. The exostoses were then cut away from the head of the radius and the head itself reduced to its normal size with the bone-cutting forceps. Its connection with the external condyle was severed and all of the articular surfaces smoothed off. The flap of fascia was now drawn downward and turned on to the joint around the inner margin of the olecranon. The proximal portion of the flap covered the trochlea, lined the olecranon depression and lesser sigmoid cavity, while the distal portion covered the external condyle. The margin of the flap was secured to the capsule of the joint on all sides with interrupted catgut sutures and the olecranon brought into position and wired to the ulna with aluminum-bronze wire. The ulnar nerve which had been displaced at the beginning of the operation to protect it from

Fig. 18.



Case VIII.—Radiograph of right elbow after operation.

Fig. 19.

Case IX.—Radiograph of left elbow before operation. Osseous tissue fills the joint and unites the bones.

Fig. 20.

Case IX.—Radiograph of left elbow after operation, showing distinct line of separation between humerus and ulna.

injury, was replaced in its groove. Subsequent events show that the facial flap was not carried sufficiently high on the anterior surface of the humerus to permit of adequate flexion of the joint. To prevent adhesion of the triceps muscle to the lower end of the humerus, the deep portion of its common tendon was folded together and sutured longitudinally to form a rope-like mass. The edges of the fascia on the posterior surface of the muscle were drawn together as closely as possible to prevent adhesion of the muscle to the skin.

Passive motions of the elbow were now performed and the muscles stretched to allow a free flexion and extension. The skin incision was closed with silkworm gut and horse-hair and the wound drained with a small rubber tube at its lower angle. The elbow was immobilized at a right angle in an external plaster cast.

A mild degree of superficial infection developed a few days after the operation and caused a slight evening elevation of temperature. It was not necessary to reopen the wound on this account as the retained seropurulent fluid escaped between the sutures. The sutures were removed on the tenth day and the elbow put through passive motions every day after this. (Fig. 18.)

September 17, 1904. He can now pass the hand through an arc of five inches. Pronation and supination are about one-half the normal degree. There is no swelling of the joint. The biceps and triceps which had atrophied from non-use are slowly developing.

Case IX.—Mrs. S. S., aged twenty-nine years; admitted to Mercy Hospital June 21, 1904.

Present Illness. Ten months ago the patient had an attack of "acute rheumatism" (?) which involved in rapid succession the joints of the fingers, left elbow, both knees and ankles and the right wrist. All of these joints were swollen, painful and tender to pressure for three weeks, during which time her temperature ranged from 101° to 103°, and she was often delirious. Temperature then became remittent, high in the afternoon and low in the morning, but the arthritis, particularly in the left elbow and right knee, remained active for four months from the time of onset. The trouble then gradually subsided leaving all of the joints

normal, except the left elbow and right knee, which were firmly ankylosed, the former slightly flexed and the latter extended. At present, her general health is good, but she still has some pain in the knee and elbow.

Previous History. "Scarlet fever and measles" when a child. Never pregnant. Family history negative.

Examination. Small stature. Fairly well nourished. Heart, lungs and abdomen negative. The left elbow is firmly ankylosed in a slightly flexed position, and permits of absolutely no motion. (Fig. 19.) There is no swelling about the joint. The right knee is extended and fixed but allows of slight passive motion between the femur and tibia. The patella, however, is united to the femur by bony ankylosis.

Operation on elbow, June 22, 1904. Usual aseptic preparation of left arm and forearm. Four per cent. solution of gutta-percha in acetone applied to the skin. A longitudinal incision, six inches long, was made on the posterior surface of the lower arm and elbow, directly over the olecranon process. It extended from two inches below the tip of the olecranon to four inches above it and divided the skin and subcutaneous fatty tissue down to the triceps aponeurosis. The skin was now dissected free from the surface of the fascia and bone for an inch and a half on each side of the incision and the edges of the wound widely retracted.

Before proceeding further with the operation, the ulnar nerve was isolated and placed on the inner side of the condyle to protect it from injury. A flap of the triceps aponeurosis, four and one-half inches long by two and one-half inches wide, was then dissected from the posterior surface of the muscle. A thin layer of muscle tissue remained adherent to the under surface of the flap and its pedicle was attached at the level of the elbow-joint. The olecranon was now detached from the ulna by means of a wire saw, which divided the process obliquely from within outward and upward. After separating the bony union between the sigmoid cavity and the trochlea, the olecranon was turned upward. Examination of the joint showed complete bony ankylosis between the humerus and ulna and the humerus and radius. The superior radioulnar

articulation was not involved and allowed of normal motion after the bones had been liberated.

The osseous union between the articular surfaces was separated with chisel and mallet, the ends of the bones smoothed off with cutting forceps and the olecranon depression enlarged by curetting out the bony deposit. The tip of the coronoid process was removed. By flexing the elbow to an acute angle the bones were separated from each other and more room secured for the next and most important step in the operation—*i. e.*, covering the ends of the bones with the fascial flap. The flap was drawn downward and turned into the joint around the inner edge of the olecranon. The entire articular surface of the lower end of the humerus was covered by the flap, the free edge of which was sutured to the periosteum well up on the shaft of the bone. The arm was now extended, the ulnar nerve replaced in its groove and the olecranon wired to the ulna in its normal position. The edges of the capsule were next approximated with catgut sutures, which should not have been done, the elbow put through passive motions to stretch the muscles and the skin incision closed with horse-hair. The elbow was immobilized at a right angle, in a posterior plaster cast, which extended from the shoulder to the wrist.

For three days after the operation her temperature ranged from 100° to 102.4°. After the third day it remained normal during the rest of her stay in the hospital. She complained of very little pain at any time. The wound healed by primary union and the sutures were removed on July 2d. She was allowed out of bed on July 5th. Passive motions were begun on the fifteenth day and performed daily thereafter. The cast was removed on the twenty-first day. She left the hospital July 29, 1904. (Fig. 20.)

September 22, 1904. Active motion carried the hand through an arc of three inches without pain. The elbow can be forcibly flexed to an acute angle and extended to 160°. Supination and pronation are rapidly approaching the normal. No swelling or œdema about the joint.

Case X.—Mr. H. B. D., aged twenty-six years; occupation, lineman; admitted to Mercy Hospital September 14, 1904.

Present Illness. Thirteen months ago, in the third week of acute gonorrhœa, the patient's left knee suddenly became swollen, painful and tender. The pain became very severe and as no improvement followed rest, hot applications, etc., a plaster cast was applied which immobilized the knee in full extension. He was confined to bed for three months and the cast remained on four months. When it was taken off the knee was stiff and attempts at active or passive motion were very painful. The stiffness and pain have persisted up to the present time and he is incapacitated. All treatment has been without effect.

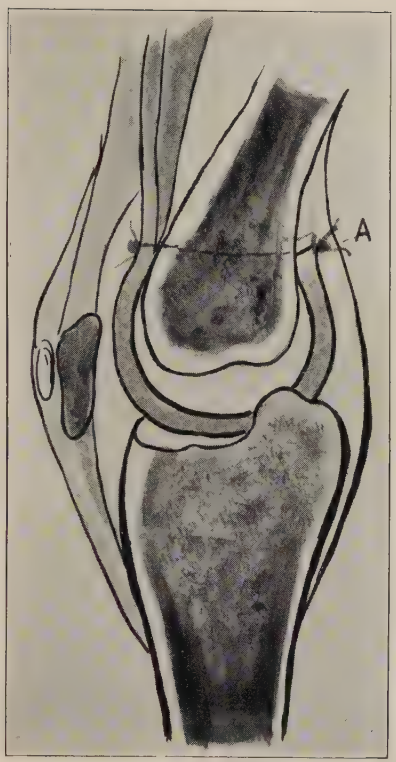
Previous History. "Typhoid fever" many years ago. "Rheumatism" fifteen years ago. Three attempts were made under anæsthesia to restore motion, in one the ligamentum patellæ was ruptured. All were unsuccessful. Family history negative.

Examination. Heart, lungs and abdomen negative. The left knee is flexed at an angle of about five degrees. It is slightly swollen and tender to pressure around the line of the joint. The patella is firmly ankylosed to the femur and cannot be moved independently. The ankylosis between the tibia and femur is apparently fibrous, as a very slight degree of motion is present.

Operation, September 17, 1904. Esmarch's constrictor around middle of thigh. A transverse incision was made extending from the inner to the outer condyle across the centre of the left patella. Patella sawn through transversely, its lateral ligaments divided and the bony union to the femur separated with chisel and mallet.

The two fragments were then retracted upward and downward, respectively, exposing the interior of the joint. Dense fibrous tissue united the femur and tibia over the entire articular surface and the capsule of the joint was greatly thickened. The capsule was now divided in a posterior direction on each side and the bones freed from each other by forcibly flexing the leg on the thigh. The fibrous union was so strong in some places that instead of tearing, it carried the bony tissue with it. The anterior crucial ligament was ruptured when the leg was flexed, but the posterior remained intact. A flap of the fascia lata and adipose,

FIG. 21.



CASE X.—Sagittal section through knee-joint, showing entire articular surface of femur covered by fascial flap, which is sutured to periosteum at A.

FIG. 22.

CASE X.—Radiograph of left knee two months after operation. Anterior view. Joint cavity is free and articular surfaces are of perfect conformation.

covering the vastus externus, was then dissected from the muscle, leaving a broad pedicle attached just above the joint level. Now, before turning the flap into the joint, the entire capsule, lateral ligaments and periarticular tissue were removed, except from the posterior margin, from both tibia and femur down to its attachment to the bone. The flap was then turned in between the bones and the entire articular surface of the femur covered by it. It was large enough to overlap the articular surface and permit its free border to come well up on the shaft of the bone, where it was secured to the periosteum with interrupted catgut sutures. (Fig. 21.)

The leg was now extended and the upper and lower halves of the patella reunited by a mattress suture of heavy aluminum-bronze wire in the bone, reinforced by interrupted kangaroo tendon sutures in the periosteum and patellar aponeurosis. The skin incision was closed with silkworm gut and horse-hair. No drainage used. An anterior plaster cast from the groin to the toes immobilized the knee in full extension. Buck's extension was applied on the tenth day and slight passive motion instituted. (Fig. 22.)

December 1, 1904. Patient is now able to walk without cane or crutch, though he uses a cane if on his feet for a long time. Motion in knee-joint is perfectly free to the extent of 15 degrees, and this is increasing daily. Patella is freely movable.

Case XI.—Mr. A. W. D., aged twenty-nine years; occupation conductor; admitted to Mercy Hospital October 27, 1904.

Family History. Negative.

Previous History. Typhoid fever ten years ago; chancroid two years ago; acute appendicitis, terminating in localized abscess, three months ago. Abscess was opened and drained, but he does not know whether the appendix was removed or not.

Present Illness. Fourteen months ago patient fell under a moving freight car and was rolled a distance of ten or twelve feet before the train could be stopped. The wheels did not pass over him, but as a result of the compression between the car and the ground he sustained the following injuries: (*a*) Severe contusion and

laceration of the soft tissues about the right knee, especially of the outer aspect; the knee-joint was opened, but no bones were fractured. (*b*) Right radius and ulna were fractured at about the middle (compound). (*c*) Right shoulder severely contused.

Suppuration developed in the right knee-joint and he was confined to the hospital for eight months. The lacerated wound of the forearm healed, but the bones did not unite. When he left the hospital the suppuration in the right knee had ceased and the wound was healed, but the patella was firmly fixed to the femur by bony union, the tibia subluxated posteriorly, and he was unable to completely extend the leg upon the thigh. Flexion in the knee was limited to 10 or 15 degrees, and he could not support the weight of his body on the right limb in walking. Owing to the malposition of the leg and foot during the time he was confined in bed, he had a pronounced drop-foot, which added to the difficulty in walking and standing.

Eleven months after the accident, as there was no effort at union in the radius and ulna, the ends of the bones were freshened and wired together. At the same time the adhesions in the right knee-joint were broken up by forcible manipulations. Since then there has been a little more motion in the knee, but he is still obliged to use crutches in walking.

Examination. Medium stature; well nourished; heart and lungs negative.

Abdomen. Scar above right Poupart's ligament, where appendicial abscess was drained.

Extremities. Right radius and ulna fractured in middle third and fragments united by fibrous tissue; no effort at bony union has occurred. Muscles of forearm are atrophied, and motion in wrist is limited.

Right leg is flexed on thigh at an angle of 140 degrees and cannot be extended beyond this angle. He can flex the knee through an arc of about 20 degrees.

Muscles of right leg and thigh are atrophied and weakened from disuse. Tibia is subluxated posteriorly and the hamstring muscles permanently shortened—the result of long-continued

flexion at the knee. The patella is fixed to the femur by bony union and permits of absolutely no motion.

Marked foot-drop exists, the contracted posterior muscles preventing flexion of the foot to a right angle.

Operation, October 29, 1904, by Dr. J. M. Neff. (1) Right leg and thigh rendered surgically clean. (2) Constrictor applied around the middle of thigh. (3) Inner and outer hamstring tendons elongated by tendoplasty. (4) U-shaped incision made, beginning on the outer surface of the thigh eight inches above the knee-joint, passing vertically downward to the level of lower border of patella, then transversely to inner side, and continuing vertically upward to a point six inches above level of joint. Incision was through the skin, fatty tissue, and fascia lata. (5) Ligamentum patellæ divided transversely and joint opened on each side of patella. (6) The joint capsule on each side of the patella incised and removed, after which leg could be flexed to a right angle without difficulty. Examination of the joint showed the following: (*a*) bony union of patella and femur; (*b*) organic adhesion of anterolateral portions of capsule to the anterior part of the articular surface of femur; (*c*) capsule of joint thickened and synovial membrane hypertrophied; (*d*) tibia subluxated posteriorly; (*e*) synovial membrane and articular cartilges of knee-joint proper normal, except anteriorly, where capsule was adherent. (7) Patella chiselled free from femur through line of union between the two bones and roughened surfaces smoothed with bone-cutting forceps. Patella then retracted upward. (8) A horseshoe-shaped flap, with its pedicle attached just above the knee-joint, was now cut out of that portion of the fascia lata which covered the vastus externus. A layer of fat was left attached to the flap. (9) A similar but smaller flap cut from fascia covering vastus internus. (10) Outer and inner flaps now turned in between the patella and femur to cover the articular surface and prevent subsequent union of the bones. (11) The upper edges of the flaps were sutured to the periosteum on the anterior surface of the femur. The apposing edges were sutured together in the median line and the lower edges to the crucial ligaments. Interrupted kangaroo-tendon sutures were used. (12)

The patella was now brought down to its normal position and secured to the ligamentum patellæ with heavy kangaroo-tendon sutures. These were reinforced by sutures approximating the cut edges of the patellar aponeurosis. (13) Skin wounds closed with horse-hair. No drainage used. Patient returned to bed and limb placed in a box.

The next morning, October 30th, he complained of severe pain and tenderness in right lower quadrant of abdomen, and at 4 P.M. his temperature registered 102.6° and pulse 136. Bowels were constipated. Calomel, 2½ grains, given in divided doses. The diagnosis of recurrent acute appendicitis was made, but operation deemed inadvisable under the circumstances.

October 31st, P.M. Temperature, 102.8°; pulse, 128. Pain in right side still severe and right iliac region so sensitive that he could not bear even light pressure.

November 1st, P.M. Temperature, 101.4°; pulse, 116. Bowels moved after enema; pain is less severe, though still present. Tenderness and marked resistance to pressure in right iliac region.

November 2d, P.M. Temperature, 101.6°; pulse, 106. Pain and tenderness in right iliac region are subsiding gradually and patient is now quite comfortable. Right lower limb placed in a straight fracture-box, and Buck's extension of ten pounds applied from the knee.

From November 2d to 12th, P.M., temperature was slightly elevated, but after the 12th it remained normal permanently. Wound healed by primary union, and the sutures were removed November 12th. Continuous extension was used until December 2d, when he was allowed out of bed for the first time. He was up every day after that date, but the extension was reapplied each night until December 10th, when it was discontinued. The posterior subluxation of the tibia, which was so pronounced before the operation, gradually lessened under the traction and was almost entirely reduced when the extension was discontinued. Passive motions of the patella and knee, with massage, were given daily after the first week. At the present time (December 10th) patient is able to bear his entire weight upon the limb, but uses

Fig. 23.

Case XI.—Radiograph of right knee taken five weeks after operation, showing patella free from femur and posterior subluxation almost reduced.

crutches in walking. The posterior subluxation is almost entirely reduced and leg can be extended to within 5 degrees of the normal. Motion in the knee-joint is perfectly free, though somewhat limited as a result of the prolonged traction and non-use. The patella is free from the femur and allows of a considerable degree of lateral passive motion. (See Fig. 23.)

Dr. Wm. Dow, of Regina, Assiniboia, Canada, in a communication dated February 26, 1904, writes as follows concerning a case on which he operated after my plan on January 2, 1904 (the case was one of double hip ankylosis from tuberculosis): "I may not have made plain my use of the fascia in description of my operation, ankylosis from tuberculosis of the hip. I stripped down the fascia from the skin and fascia flap in like manner to the way I saw you do, cutting some fibres of gluteus maximus muscle to place it round the head (end of neck, as head was gone from necrosis) and stitched it to original capsule around neck of bone on as much of neck as contained original capsule, thus surrounding the end of the bone with the fascia lata. The end of bone was smoothed with bone forceps and the fascia when brought down made to surround it and stitched as described, only at upper part of neck I had no original capsule and stitched part to tissues to help hold it down in place. The end of bone was encapsulated with the fascia and think it will be all right. There is still a very slight serous discharge, but there is considerable degree of motion at hip and the thigh is filling out. It is now much larger than the opposite thigh. His pulse has slowed some lately. Temperature remains normal. Think I will remove the extension entirely in a few days and will try him on his feet in a week if serious oozing ceases. Will send report of his condition at a later date."

The history of the formation of new joints begins with J. Rhea Barton, of Philadelphia. To him belongs the honor of the first attempt (in 1826) to rectify an angular, true ankylosis of the hip-joint by osteotomy.

Briefly, his operation consists in incision of skin, muscles,

division of bone, through the great trochanter and a part of the neck of the femur. Then prevent bony union by movements, which will induce ligamentous attachment *only*.

Dr. J. Kearney Rodgers, of New York, modified his operation in 1830, by removing from between the trochanters a disk of bone.

In 1838, A. Bérard, writing on ankylosis of the temporomaxillary joint, advised the method of J. Rhea Barton—section of condyles and prevention of bony union by means of motion, in order to form a false and new joint.

John Murray Carnochan, of New York, claims to have performed in 1840 for the first time an operation in order to establish a new joint formation of a "maxillary pseudarthrosis." In operating upon a case with ankylosis of the temporomaxillary joint, he fractured, *accidentally*, the maxilla, which suggested to him later the advantage of dividing the maxilla in order to create a pseudarthrosis of the maxillary joint. In that case, he tried to prevent bony union by interposing a piece of wood between the operated bony surfaces. He also recommended the patient to chew. The technique followed by Carnochan consisted of division of the temporal and masseter tendons, section of the ramus, and then prevention of bony union by interposing cotton. The bone should be divided through the mouth.

In his *Lectures on Surgical Anatomy and Operative Surgery*, he showed that in some cases of ankylosed temporomaxillary joint the subcutaneous tenotomy of the masseter and temporal is practicable and rational.

Dieffenbach, in his *Operative Surgery*, mentions the treatment of ankylosis of temporomaxillary joint by "section of bones." On page 774 of the same work, he advises section of the masseter and formation of a new joint in cases of ankylosis of the temporomaxillary joint.

Esmarch is one of the surgeons who also recommends the creation of a pseudarthrosis in ankylosis of the temporomaxillary joint. He advises surgical intervention only in cases where the immobility is due to cicatricial tissue; in other words, he does not operate upon joints with any structural changes.

In his thesis, Charles Richet advises this technique in cases of ankylosis: Longitudinal incision of periosteum, which is denuded and preserved, "in order to form the new articular capsule." He then divides the bones and recommends the patient to chew, so as to prevent bony union.

Rizzoli and A. Verneuil restored motion—the former in three cases, the latter in one case of temporomaxillary ankylosis, by section of bony extremities and prevention of union by movements. The result was a pseudarthrosis.

FORMATION OF NEW JOINTS BY MUSCULAR INTERPOSITION.

Lately, the ankylosis of joints has been corrected by osteotomy followed by muscular interposition. Nélaton reports two cases of ankylosis overcome by this method. *Bull. et Mém. de la Soc. de Chirurgie*, 1902, p. 687).

The first case was one with double ankylosis of hip-joint following articular rheumatism. The patient was unable to walk or to stand up. An operation was performed as follows: Antero-external incision of skin, section of muscles and capsule; extrusion of the head of femur; enlargement of cotyloid cavity. Next, Nélaton interposed between the head and acetabulum, a strip of fascia lata, two fingers in width and five inches long. Then, suture of muscles with catgut and of skin with horse-hair. The corresponding leg was extended by weights of ten to twelve pounds. Union was obtained in fifteen days, and two months later the patient was able to walk. Examining the patient two years later, Nélaton found all the movements free and painless. He walked more or less like an individual with congenital dislocation of hip-joint.

The second case was a young man, aged twenty-nine years, who suffered from acute and generalized rheumatism, followed by ankylosis of both hip-joints and of the lumbar spine. The thighs were flexed upon the pelvis (fifty degrees) in slight abduction and the knees separated by a distance of eight inches. Technique: A one-inch incision on the anteroexternal margin of the great

trochanter; incision of muscles and capsule; extrusion of the neck and head of femur; enlargement by scissors of the old cotyloid cavity; interposition of a piece of fascia lata, of four to five inches. Healing was obtained in three weeks. The movements of the new joint were very good, but on account of the pressure exerted by the traction apparatus, the patient developed an eschar of the head of the fibula, followed by a paralysis of the external popliteal nerve which, of course, made the extension of the foot impossible. Nélaton says in his report: "I believe that the muscular interposition is the strongest medium that we possess in order to combat the bony ankylosis of a joint."

Ankylosis of shoulder-joint, treated by muscular interposition by M. Coville (case reported by Nélaton). A young woman, aged twenty-two years, with absolute ankylosis of the shoulder-joint, following trauma. On May 19, 1903, Coville made a four-inch incision, starting below the clavicle and passing externally to the coracoid, then down the arm, following the fibres of the deltoid. The latter was incised outside of the groove separating it from the pectoralis. The head of the humerus was extruded and divided at the level of the anatomical neck. The long strip of the deltoid was then cut transversely, the superior part being left adherent. A piece of four inches, obtained by the transverse section, was then interposed between the surface of the humerus and glenoid cavity. Coville perforated the capsule with a probe so as to prevent wounding the musculospiral nerve. A counter incision was made at the same level and a thread passed through this opening, surrounding in the form of a loop the extremity of the muscular strip and by tightening it, applied the muscle in the articular cavity. Three days later movements of the new joint were performed. The result was good; the woman was able to sew (she was a tailoress). Only abduction was limited.

Berger reports the following case: Ankylosis of elbow-joint of several years' standing, for which amputation had been advised.

Technique: Resection of one inch from the humerus and one-half inch from ulna. A piece of the olecranon, covered with periosteum, was left in order to preserve the insertion of triceps. The extremity

of the humerus was carefully rounded, so as to imitate the normal form. In order to assure mobility of the new joint and prevent return of ankylosis, the author placed a piece of muscle taken from the pronator radii teres between the bony extremities, which was fixed by several sutures to the brachialis anticus. The author attributes the good result that he obtained to the muscular interposition.

In addition to the attempts to overcome the ankylosis, some authors have tried to correct the defect by interposing soft tissues between the bone surfaces.

Föderl, for example, experimenting upon animals found he could restore motion in the temporomaxillary joint, ankylosed after resection, by interposing between the bones animal membranes, such as pieces of bladder or the wall of ovarian cysts.

Chlumsky restored motion in ankylosis, consecutive to experimental resection in animals, by first covering the bony extremities with collodion and then by interposing between them plates of celluloid, silver, tin, rubber, etc. The animals were able to move their joints just as well as before the operation. Later on he used plates of magnesium.

Some surgeons advise another operation for ankylosis. T. Wolff reported nine cases of ankylosis in 1895 and 1897 in the *Berliner Chirurgen Vereinigung*. He made use of "arthrolysis." Section: chisel and excision of all the fibrous tissue which hindered movements. The operations were followed by good results.

Von Eiselsberg reports good results in one only of the two joints where he used the same method. Kocher, while in favor of arthrolysis, modifies it by putting the bony extremities, after the arthrolysis, in a position of dislocation, which he reduces eight to fourteen days later.

Quenu (*Société de Chirurgie*, June 25, 1902) reported a case of ankylosis of the elbow-joint, treated by interposition of soft tissues, after an extensive resection of the bony extremities. He first largely resected the ends of ulna, radius, humerus, and then interposed the anterior ligament. The result was very satisfactory.

Delbet praises the method of "muscular interposition" in cases of ankylosis.

In our work we have been able to produce, by the interposition of flaps of fascia and muscle covered with a layer of adipose tissue, normal movable joints, with capsules and intra-articular collagen fluid. This, we believe, is the first systemic production of new and practically normal articulations.

Bibliography.

Albany Med. Ann., 1903, xxiv. 268–275.
Archiv f. klin. Chirurgie, 1902, 6–7.
Barton. North American Medical and Surgical Journal, 1827, p. 290.
Berliner klin. Wochenschrift, August, 1882.
Bernays, A. Die Entweckelungsgeschichte des Kniegelenks des Menschen und Bemerkungen über Gelenke in Allgemeinen.
Berard, A. Dict. de Med. en 30 vol., 1838, T. xviii. p. 440.
Berger. Bull. et mem. de la Soc. de Chir., 1903, vol. xxix.
Chlumsky. Wien. klin. Woch., 1902.
Coville. Bull. et mem. de la Soc. de Chir., 1903, p. 1185.
Dental Digest. Chicago, 1903, ix. 287.
Dieffenbach. Operative Surgery.
Fick, L. Ursachen der Knochenformen, 1857.
Föder. Wien. klin. Woch., 1902, p. 859.
Gegenbaur. Lehrbuch der Anatomie des Menschen, pp. 136–137.
Gegenbaur. Zur Morphologie der Gliedmassen der Wirbelthiere, Morphol. Jahrbuch, 1876, Bd. xi.
Gothe, A. Beitrage zur Vergleichenden Morphologie des Skeletsystems der Wirbelthiere. Arch. für Mikr. Anat., 1877, Bd. xiv.
Henke and Reyher. Sitzung. der k. k. Wiener Akademie, 1875, Bd. lxx.
Hepburn. Jour. Anat. and Physiol., xxiii. p. 507.
Huxley. Lectures on the Elements of Comparative Anatomy, London, 1864.
International Encyclopedia of Surgery, vol. iii. pp. 526–527.
Jahresberichte auf dem Gebiete der Chir. (Hildebrand), 1900, pp. 237, 296.
Minot. Embryology, p. 460.
Boston Medical and Surgical Journal, 1860, p. 59.
Nélaton. Bull. et mem. de la Soc. de Chirurgie, 1902, p. 687.
Richet. Thèse de Concours: Des Operations Applicables aux Ankylosis.
Schwegel. Sitzung. der k. Akad. d. Wissensch. Wien. (Math. Natur. Cl.), 1858, Bd. xxx. p. 337.
Transactions of the American Orthopedic Association.
Verneuil, A. Archives de Médecine, 1860, p. 284.
Wiener klin. Wochenschrift, 1902, Bd. xv. p. 859.

NEW AIDS TO THE SURGICAL DIAGNOSIS OF DISEASES OF THE KIDNEYS AND THEIR VALUE.

By ARTHUR T. CABOT, M.D.,
BOSTON.

The means at our disposal for the determination of the condition of the kidneys are:

1. General chemical and microscopic examination of the urine.
2. Elimination of drugs and coloring matters that pass out of the kidneys as through a filter (methylene blue).
3. Elimination of substances that require an excretory effort of the kidney cells for their separation (phloridzin glycosuria).
4. Cryoscopy, or the determination of the molecular concentration of the urine as compared with that of the blood by observation of their relative freezing points.
5. Cystoscopy.
6. Ureteral catheterization.
7. Intravesical separation of urines.
8. Operative exploration.

The distinctly new step in renal investigation has been the application of the above-mentioned tests of excretory ability to the separated urines from the two kidneys.

My experience in the exploration of the ureters and in the segregation of the urines has been so much less than Dr. Harris' and some other members of the Association that I shall not take time in discussing the technique of any of the procedures, but wish to speak mainly of the class of facts that we can establish by such exploratory measures as we have at our command.

If it becomes important to learn what we can of the individual work of each kidney we may obtain the separation of the urines

either by ureter catheterization or by bladder segregation. For this latter purpose we may use Dr. Harris' instrument or that of Cathelin or that of Luys.

I have used Dr. Harris' instrument with good results in the female, but have found it less satisfactory in my hands in applying it to the male bladder. This has probably been due to the fact that most of the cases in which I have had occasion to use it in the male have been in old men in whom the prostate makes formation of the central ridge less satisfactory.

The instruments of Cathelin and Luys are even more dependent upon a comparatively unaltered bladder-floor.

It becomes important then, before using any of these instruments, to make a thorough cystoscopic examination of the bladder to determine whether there are any irregularities of the walls due to tumor, pouches, or trabeculated conditions.

During this examination we learn, also, whether there are any ulcerations of the bladder wall which might confuse our results by supplying leukocytes or blood to the fluid drawn seemingly from the kidneys.

An inspection of the ureteric orifices will often tell us a good deal about the condition of the kidneys above, and during this examination it is well to have an assistant make pressure over the kidney corresponding to the ureter which is at the moment in the field.

In conditions of pyonephrosis this frequently produces a little jet of pus which can be plainly recognized, and when such a flag of pus is hanging out of the ureter the question of whether urine is flowing beside it or not can usually be determined.

Since this was written still another method of obtaining an imperfect separation of the urines has come to the notice of the writer.

Dr. Giordano, of Venice, and Dr. Nicholich, of Trieste, have independently advised the following plan, which is so easy of application that it can be quickly tried, and in event of its failure other more complicated methods can be resorted to.

It consists in emptying the bladder and thoroughly washing it. Then, with the catheter still in place, firm massage is made over

one kidney, and in practice Dr. Nicholich found that he at once obtained a small quantity of urine. If this urine is clear, massage may be at once made over the other kidney, and a specimen of its urine can thus be obtained.

If the urine from the first kidney is cloudy the bladder should be again washed out before an effort is made to obtain urine from the second kidney.

In two cases to which Dr. Nicholich applied this method he obtained clear urine from one side, and cloudy, purulent urine from the other, and in each case he removed a tuberculous kidney from the side from which he obtained cloudy urine.

Some conditions of the ureter, such as stricture or impacted stone, can only be determined by catheterization, though they may be suspected from the clinical symptoms and from the inspection of the ureteral orifices.

When seeking to know what formed elements, pus, blood, or crystals, are coming from each ureter, catheterization is more sure to deliver only kidney constituents. It is to be remembered, however, that the introduction of the catheter may cause hemorrhage to obscure or vitiate the results.

When we are separating the urines to determine by their chemical examination what the functional capacity of each kidney is, I am inclined to favor the bladder segregation of urines if it works satisfactorily rather than ureter catheterization, for in some cases there is danger of promoting the extension of inflammation back toward the kidneys by introducing an instrument through an infected bladder into a still uninfected ureter.

This danger, which may be reduced to a minimum in the hands of a thoroughly skilful cystoscopist, becomes a serious menace when the instrumentation is in less experienced hands.

It seems as if it would be a comparatively simple matter to examine the urines from the two kidneys and to thus determine quite surely the functional capacity of each organ. Such is, however, not the case. A long series of examinations of the excretion of urea show that the amounts of urea vary greatly from day to day, and it has been likewise found that the amounts of urea

from each kidney may vary very considerably from hour to hour. It is only by collecting the urines on several different days, and by prolonging each segregation over a considerable period of time that we can be sure of getting an accurate idea of the relative work of the kidneys. It is likewise an observed fact that when one kidney is badly disorganized the other kidney often does much less than the normal amount of work. Whereas, after the removal of the diseased organ the amount of urine and urea secreted rapidly rises to the normal.

In such a case, if we depended upon the segregated urines to determine whether it was a safe case to operate upon, we might readily be deterred by the greatly diminished work of the kidney upon which we had to depend after operation, while the event proves this fear to be groundless.

In a similar way I have found that the excretion of sugar after the exhibition of phloridzin gives but little guidance as to the capacity of the kidneys to stand operation, and I have seen patients whose kidneys, judged by the phloridzin test, were doing but one-third or one-fourth of the normal amount of work, who have gone with safety through severe operations upon the urinary organs.

I think it should not be forgotten that manipulations within the bladder, especially if repeated and prolonged, often greatly aggravate existing inflammation there. A patient with a tuberculous kidney and with tuberculous ulcerations of the bladder may be thrown into a high fever by such too curious instrumentation, and the risks of the subsequent nephrectomy may be thus considerably increased.

Before pursuing our scientific investigations to the final demonstration then, we should be sure that we have not sufficient data to safely act upon.

A ureter catheterization to convince us of the practical confinement of the disease to one side and to assure the existence and relative health of the other kidney will give us the information we need to show the propriety of an operation. If we delay to make a careful study of the exact amount of work then being done by the more healthy kidney we shall expose our patient to

a needless discomfort and risk and shall very likely be led to underestimate the work of which it is capable when freed from the load laid upon it by the inflammatory focus in the other kidney.

My conclusions from the experiences that I have had and from my study of the work of others is that the segregation of the urines is of great use sometimes in deciding the question as to which kidney is diseased or even as to which is most affected.

The determination of the functional power of each kidney by testing the elimination through it may be of assistance by adding strength to what other evidence we have, but would be often misleading if too implicitly relied upon for deciding operative measures.

DISCUSSION.

Dr. Arthur Dean Bevan, of Chicago.

I have been very much interested in listening to Dr. Cabot's presentation of the subject, and I want to speak of one or two points which have particularly interested us in our work at the Presbyterian Hospital during the last year and a half. One is as to the value of cryoscopic examinations in kidney work. Fortunately, at this institution in Chicago we have one of our younger men, Dr. Tiekin, on the internal medical service, who has devoted a great deal of time to cryoscopic examinations, and he has made these examinations in connection with my surgical work. He has made over three hundred cryoscopic examinations. I cannot speak entirely as to his conclusions derived from that large amount of work, but I have obtained some idea of the value of his work as applied to my own cases, some thirty in number, and I should sum up the conclusions briefly in this way: It has been proven to be of no value whatever in our work. Cryoscopic examination for determining the freezing point of the blood has been interesting and is of distinct value, although it has not been determining. As you know, the freezing point of the blood is 0.056 to 0.057, and it is constant. Practically, between these figures is the normal temperature of the blood. We have found that it is exceptional for us to find, except in pathological conditions, a case varying very much from 0.056. That expresses the working possibility of the kidneys. For instance, in high concentration, due to deficient kidney action, as in anuria, we have found the freezing point reaches to 0.078. Another condition which modifies the blood is that of anæmia, where we have hemorrhages into the kidney, and, secondly, anæmia from the hemorrhages. Cryoscopic examination of the blood shows that it is 0.051. This presents an interesting point. If in anæmia the cryoscopic examination shows 0.051, if it were not for the anæmia and lack of power of the kidney to excrete, the resulting concentration of the blood find would be 0.061, the best possible combination of conditions, a low point for the anæmia and a high point for the kidney function.

I agree with Kümmel, from the examinations we have made, that it is dangerous to operate upon a case where the blood examination is over 0.060 or more. These points should be thoroughly considered. Kümmel, in his last article in the *Beiträge*, and in a subsequent monograph by his assistants, brings out the point that he has lowered the mortality from nephrectomy by following out these cryoscopic examinations. The value of this is more apparent than real, because he has

only operated on certain cases, and in that way has lowered his mortality. To my mind, it is quite possible that some of the cases on which he refused to operate might have been benefited by operation.

The next point to which I desire to call attention is the use of the *x*-ray in kidney stone work and kidney work generally. I believe that we have in the *x*-ray, if properly followed out, a most valuable means of diagnosis in kidney work. It foreshadows, as a means of diagnosis, entirely cryoscopic examination, and I want to say even examination by the cystoscope, the segregator, or ureteral catheter. I think that with our modern refined means of chemical and microscopic examination of the urine, with very well carried out *x*-ray work, and with the symptom-complex, we have three of the most essential factors in making a diagnosis of disease of the kidney. I would consider the use of the cystoscope or ureteral catheter as of minor importance, as it is only occasionally we feel we must resort to the ureteral catheter, and it is always with the feeling that it is a menace, which, as Dr. Cabot pointed out this morning, should be omitted if a diagnosis can be arrived at by any other means. I want to say this relative to kidney stone work. The work must be done properly. The majority of the kidney stone work which I have seen has not been well done, and the *x*-ray has been condemned and belittled, because the work has been badly done and misinterpreted. I do not make any special claim for the work which we have been doing. My assistant, Dr. J. F. Smith, has assembled a technique for *x*-ray work which has given us very satisfactory results. In an article in a recent issue of the *Annals of Surgery* he has collected my last twenty-six cases, which he examined at my service at the Presbyterian Hospital. Since that time we have had several more. Of these 26 cases, 13 gave positive results—that is, showed definitely the existence of stone or stones; 13 of them gave negative results. In 1 case there was a doubtful diagnosis. In the doubtful case operation revealed a single oxalate stone the size and shape of a pumpkin seed lying well up under the last rib. More careful examination of the skiagraph in this case showed a rather vague shadow directly over the last rib. The failure was due perhaps more to an error in the interpretation of the skiagraph than to the skiagraph itself. In the 13 cases in which a negative diagnosis was made, the following conditions were found at operation: tuberculosis, 5 cases; pyonephrosis, 2 cases; essential renal hemorrhage, 2 cases; cystonephrosis, 1 case; hydronephrosis, 1 case; polycystic kidney, 1 case; hypernephroma, 1 case.

There is one point I wish to speak of in regard to the technique, and it is this: We use a twenty-two-inch machine. A lead plate is put on the table; the patient put on the lead plate in position, so that the lum-

bar spine is brought closely into contact with the plate. The tube is covered with a metal hood. The small opening, opposite the focus of the heavy metal cuff, extends from the air to be taken to the tube. The exposures are short, varying from about a minute to eight minutes.

There is this to be said in regard to the interpretation of the plates: We have found a great deal of satisfaction from the scheme advocated by Kümmel, of making a photograph in a dark room, only light coming through the plate, and examining the plates with a pair of opera glasses. We have taken as many as eight or ten pictures of a single case.

Dr. Leonard Freeman, of Denver, Colorado.

Something over three years ago it occurred to me that it was possible to segregate the urine by passing an instrument into the bladder and forming a partition without inserting a rod into the rectum, as with the Harris segregator. I therefore devised an instrument for the purpose, in which a rubber partition was lifted on a wire by turning a small screw in the handle of the instrument. The rubber, when not put on the stretch, contracts into a small space along the curve of the catheter-like instrument. I used this device with success in two cases. But the instrument was rough and crude, and I put it on one side. It did not seem to me any better than the Harris segregator, and I neglected to have another made which was smoother, and could be used with more ease. Two years later a similar instrument was brought forward and described by a surgeon in Paris. As regards the similarity of the two instruments, they can hardly be told apart by the illustrations, except that he uses a chain in the place of a wire. I do not claim priority, for I do not think the instrument is one of great value, nor did I publish a description of it at the time I devised it. At the same time, I thought it might be of interest for the Association to know that two things so exactly similar could be brought forward by two different men at nearly the same time.

Dr. Richard H. Harte, of Philadelphia.

In regard to the segregator spoken of by Dr. Freeman I purchased practically the same instrument in Paris last winter, which is known as the Luys segregator. It was used extensively in Hartmann's clinic. I agree with Dr. Freeman that the instrument is not of great practical value, and that it is liable to mislead one. I have tried it a great many times by injecting coloring fluid on one side and having it reappear on the other. The similarity of these two instruments only shows how often a thing is brought out in one country and cast aside, then subsequently brought out in another country and lauded as being the only

way of accomplishing certain results. If the base of the bladder were always uniform it can readily be seen why this instrument might be used with a definite degree of success.

Dr. Cabot. I left out of consideration the use of the *x*-ray, which Dr. Bevan has shown is an important diagnostic aid in our surgical work, merely because I did not count it among the most recent methods of investigating kidney condition. I entirely agree with Dr. Bevan as regards the value of the *x*-ray when calculus is suspected. I have had great assistance from the use of the *x*-ray in the diagnosis of stone in the kidney, and I regard it as one of the most important measures we have for making that diagnosis.

A CASE OF SPLENECTOMY FOR MYELOGENOUS LEUKÆMIA.

By MAURICE H. RICHARDSON, M.D.,
BOSTON.

In an article on the "Surgery of the Spleen," by Dr. Warren, the details of the following case were published, with remarks upon it by Dr. Whitney (see *Annals of Surgery* for May, 1901).

In brief the case is as follows:

Mrs. E. M. D., a patient of Dr. J. F. Croston, of Haverhill, I saw on December 12, 1900. In February, 1900, she first noticed a bunch in the left side of the abdomen. When I was called to see her I expected from the history to find an ovarian tumor with twisted pedicle. The patient's mind had been prepared for operation, and everything was in readiness for it. Under ether the tumor was clearly an enlarged spleen. The outline was characteristic, the spleen was freely movable, and the patient was in excellent condition.

No examination of the blood had been made, and none was at the time possible. The patient had with the greatest reluctance consented to operation. The physician and the family were sure that she could never again be brought to consider an operation—a conviction which subsequent experience showed to be correct.

The question whether to remove the spleen or not had to be decided upon the spot. The enlarged spleen might mean any disease of that organ, associated with great hypertrophy. All splenic tumors are necessarily serious, excepting perhaps the chronic enlargement seen in malarial districts. In some tumors of the spleen extirpation promises well for permanent cure; in others the outlook is practically hopeless. Without prolonged

study of the case and careful blood examination it was impossible to give any opinion of value as to which class this tumor might belong.

The question of operation was carefully but briefly considered. The possibility of a myelogenous leukæmia was the most conspicuous feature of this case. I had seen many such cases, in none of which did extirpation of the spleen present the least hope of success. Indeed, I had never seriously considered operation.

In the present case, even if the spleen were a part of a leukæmia, its great mobility promised an easy and bloodless operation. If any spleen in this form of leukæmia would ever justify extirpation, this one would. If there was no leukæmia, in the absence of malarial history this spleen belonged to the class of anæmias, and extirpation would give every chance of success.

I decided to operate, for if ever a splenectomy in myelogenous splenic leukæmia could be justified by prospective ease of technique it would be in this case. Moreover, the long-discussed questions of surgical treatment could better in this than in any other case that I had ever seen be definitely settled. However discouraging the experience of others had been in the removal of the spleen, it had been no less successful than medical treatment had always proved eventually. In a word, if splenectomy was ever to be justifiable in this disease—thus far so hopeless—it would be in this case.

The spleen was quickly removed without the loss of a teaspoonful of blood. The specimen was examined the next day by Dr. Whitney and the diagnosis of splenic myelogenous leukæmia was made. His report was as follows:

"SPLEEN. Leukæmia: The spleen was removed by Dr. M. H. Richardson on December 12, 1900, and was received within three hours of the time of its removal and while yet warm. It was very much enlarged, weighing 2275 grams and measured 25 cm. in length by 16 cm. in width and 9 cm. in thickness. Its shape and form were, in general, regular, but on one part of the surface there was a slight depressed area measuring 4 cm. in greatest extent, and of a deep yellow color. This was evidently the result of an anæmic

necrosis; otherwise, the spleen presented no remarkable appearance externally. The capsule was smooth and of normal color. It was of moderate firmness.

" On section it was uniform in texture and of a pale, grayish-red color. The openings of the vessels were visible, the follicles not to be made out with the eye, and the trabeculæ only here and there to be seen. At the hilus was a large vein filled with a loose, grayish-red thrombus. The blood which came from the vessels was of a pinkish-red color and formed rather loose coagula. Lying at the hilus, attached to the spleen, was a small lymph node the size of a bean, and another a little larger had been removed separately.

"*Microscopic Examination.* The spleen was hardened in Zenker's fluid and stained in various ways. With a low power the follicles were seen as occasionally widely separated accumulations of lymphoid cells which stained deeply. Between them the spleen pulp was very much increased; the openings of the veins were prominent and could be readily detected. On examination with a high power numbers of large mononucleated cells were found lying in the meshes of the reticulum associated with eosinophiles in large numbers. The reticulum was not increased in thickness, but the spaces seemed to be dilated and in this way the increase in bulk was brought about.

"The examination of the lymph nodes showed the lymph channels filled with large mononuclear cells, among which were occasional eosinophiles. The medullary strings were replaced by similar tissue, but less compact, and in which were very numerous eosinophiles and large multinucleated protoplasmic masses (giant cells). There was only a narrow zone of lymphoid tissue to be found in the periphery. The infiltration in the gland had apparently taken place from the hilus outward.

" Microscopic examination of the blood, taken at the time of the operation, showed the characteristics of an advanced leukæmia, viz., myelocytes, largely increased number of the eosinophiles and the presence of macrocytes and microcytes, together with numerous megaloblasts and normoblasts. The absence of lymphoid cells was noticeable. Examinations of the blood, made at short inter-

vals until a month after removal, showed essentially the same features without any material change except in the last examination, January 10th, when there appeared to be fewer myelocytes in proportion to the polynuclear leukocytes. There was no increase in the lymph elements."

The patient made a quick recovery, and was soon up and about. She improved wonderfully in health, and became able to perform her household duties and to enjoy life.

The blood was repeatedly taken and examined by Dr. Jones, who spent much time in the care and study of this case.

The patient early began to object to the taking of blood for examination, though every effort was made to induce her to consent. The more that was done for her the more obstinate and suspicious she became.

For two or three years she seemed in perfect health. The family moved about the State, and was very difficult to trace. Finally, the patient came under the care of Dr. F. W. Anthony, of Haverhill, who, in February, 1904, reported as follows:

"The patient has been quite well since the operation, except for a profuse flow every two weeks. This flow continued up to four months ago, since when there has been none. Her knees have been painful for some time, but are better now. Seven months ago she began to have attacks of profuse nosebleed, which recurred every two or three weeks, and later she had attacks of rectal hemorrhage, at intervals of three or four weeks. A short time ago she noticed pain and swelling of the left fourth metacarpal, with spontaneous fracture. The right wrist has been swollen at times. The eyesight has been poor for seven months. The left optic nerve is nearly, the right entirely, destroyed. There are no knee-jerks. The Argyll-Robertson pupil reaction is present. There has been difficulty in walking, but no general ataxia; rather a general muscular weakness. The patient has been completely blind for two weeks. She is now stupid and sleeps most of the time. She does not want to be touched or disturbed in any way."

Dr. Jones made another attempt to get a specimen of the blood, but without success.

On November 16, 1904, Dr. Anthony reported:

"In a general way I saw her in 1903. She had then a typical locomotor ataxia, absent patellar reflex, ataxia of station and gait, eyesight nearly absent, spontaneous fracture of one or two fingers, painless swellings of several joints, general weakness. She complained of no abdominal symptoms. She declined all interference, even to the extent of obtaining a drop of blood for examination, and died the picture of death from locomotor ataxia."

I regret exceedingly that I am unable to present the details of this patient's final condition. A few things are, however, worthy of mention. The first important fact was the great improvement in the blood which followed the operation. It became normal. How long the blood continued so I cannot say. It was probably for some time, for her general health was apparently restored. There was no greater improvement, however, than is seen occasionally in the regular course of the disease under medical treatment. We cannot, therefore, claim for the operation the improvement seen in this case.

The second fact is the distressful condition that the patient was in for some months previous to her death. I did not see her, but she was reported by Dr. Jones and Dr. Anthony to be a terrible sufferer. It is a question whether her condition was worse than usual in such cases. I do not know. It could not, under any treatment, have been any worse. I do not think, however, that it is any fairer to assume that the late bad condition was the result of the operation than to assume that the early improvement was the result of it.

It seems to me a more reasonable assumption that the extirpation of the spleen had no effect upon the disease, one way or the other, early or late; that the improvement noted was the result of medical treatment following the operation; that the final break-up was the natural course of the disease.

Finally, I would say that if the early success of this case has encouraged others to extirpate a spleen in myelogenous leukæmia,

it has done distinct harm. That the case may no longer be quoted as a case of successful operation in this disease it has seemed important to publish the ultimate result. It is to be regretted that the patient could not be studied and that no autopsy was made.

It is quite possible, of course, that my conclusions are unwarranted. A disease in which successful extirpations of the spleen are so unusual that the very success of the operation is to some minds the strongest evidence against the diagnosis—in which almost the only successful operation has been followed, after temporary improvement, by a distressing death—such a disease must by common sense be removed from the category of surgical affections, even if there is, as in this case, no positive proof that the final bad result is directly dependent upon the operation itself.

INDEX.

Abbe, Robert, gastrostomy in œsophageal stricture, 170
subtle power of radium, 253, 261
unavoidable calamities after surgical operations, 290
Accessory spleens, 220
Acute pancreatitis associated with gallstones, 103
Address of the President, 1
Allen, Dudley P., papillary cysts and tumors of the ovaries, 99
Andrews, E. Wyllys, duodenal ulcer, 72
Ankylosis, 315
Antoine Francois Saugrain (de Vigne), 1
Arthroplasty, 315
Asepsis, some studies in, 41
Aseptic surgical operations, minimum requirements for, 18, 28

Bell, James, acute pancreatitis associated with gallstones, 103
Bevan, Arthur Dean, surgical diagnosis of diseases of kidneys, 382
Bile-duct, common, gallstones in, 232
Bridging of nerve defects, 173
Brophy, Truman W., treatment of congenital cleft palate, 124, 141
Bunts, Frank E., gastrostomy in œsophageal stricture, 170

Cabot, Arthur T., new aids to surgical diagnosis of diseases of the kidneys and their value, 377, 385
Cancer, colonic, 241
Carcinoma of liver, 196
Carson, N. B., excision of clavicle, 248
Certain rare and unavoidable calamities following surgical operations, 273
Clavicle, excision of, 248
Coley, W. B., papillary cysts and tumors of the ovaries, 100
requirements for aseptic surgical operations, 56
Colonic cancer, 241
Congenital cleft palate, treatment of, 124
Conner, P. S., removal of shaft of tibia for osteomyelitis, 85

Dandridge, N. P., address of the President, 1
Decapsulation in nephritis, 263
Dunn, James H., gastrostomy in œsophageal stricture, 159, 171
Duodenal ulcer, 58

Evolution of surgery, 143
Excision of clavicle, 248
Exophthalmic goitre, thyroidectomy for, 210

Ferguson, Alexander Hugh, duodenal ulcer, 73
operations for carcinoma of liver, 208
nephritis treated by decapsulation and nephrotomy, 263
resection of upper jaws, 230
thyroidectomy for exophthalmic goitre, 218
treatment of congenital cleft palate, 139
Final results in secondary sutures of nerves, 186
Fracture of lower jaw, splint for treatment of, 296
Freeman, Leonard, gallstones in the common bile-duct, 240
operations for primary carcinoma of the liver, 196, 209
surgical diagnosis of diseases of the kidneys, 384
unavoidable calamities after surgical operations, 293

Gallstones in the common bile-duct, 232
Gastric and intestinal anastomoses, use of segmented ring in, 111
Gastrostomy in œsophageal stricture, 159
Gould, Alfred H., clinical and experimental study upon the use of the segmented ring in gastric and intestinal anastomoses, 111
Graham, Christopher, duodenal ulcer, 58

Harte, Richard H., surgical diagnosis of diseases of the kidneys, 384
Harrington, Francis B., clinical and experimental study upon the use of the segmented ring in gastric and intestinal anastomoses, 111, 122
Harrington, Charles, some studies in asepsis, 41
Hearn, W. Joseph, resection of upper jaws, 229

Intestinal stenosis, new operation for, 241
Interdental adjustable metallic splint for the treatment of fracture of the lower jaw, 296

Jaw, lower, fracture of, metallic splint for treatment of, 296
Jaws, upper, resection of, for osteochondromyxosarcoma, 227
Johnston, George Ben, complete removal of the shaft of the tibia for osteomyelitis with restoration of bone, 75
Jonas, August Frederick, splenomegaly, accessory spleens and splenectomy, 220

Keen, W. W., operations for carcinoma of liver, 196
requirements for aseptic surgical operations, 55
resection of upper jaws, 229
subtle power of radium, 261
Kidneys, diagnosis of diseases of, 377

Leukæmia, myelogenous, splenectomy for, 386
Liver, carcinoma of, 196

McArthur, L. L., operations for carcinoma of liver, 208
papillary cysts and tumors of the ovaries, 101
McGraw, Theodore A., new operation for intestinal stenosis, with especial reference to colonic cancer, 241
McMurtry, Lewis S., unavoidable calamities after surgical operations, 289
Matas, Rudolph, on interdental adjustable metallic splint for the treatment of fracture of lower jaw, 296
resection of upper jaws, 230
Mayo, C. H., thyroidectomy for exophthalmic goitre, 210, 219
Mayo, William J., duodenal ulcer, 58, 73
unavoidable calamities after surgical operations, 293
Maury, J. W. Draper, use of the segmented ring in gastric and intestinal anastomoses, 121
Mears, J. Ewing, evolution of surgery, 143
treatment of congenital cleft palate, 138
Mixter, S. J., resection of upper jaws for osteochondromyxosarcoma, with osteoplastic formation of new hard palate, 227
Monks, George H., what are the minimum requirements for aseptic surgical operations, 18
Moore, James E., papillary cysts and tumors of the ovaries, 100
Murphy, John B., ankylosis, arthroplasty, 315
duodenal ulcer, 73
Myelogenous leukæmia, 386

Nancrede, Charles B., requirements for aseptic surgical operations, 53
unavoidable calamities after surgical operations, 293
Nephritis treated by decapsulation and nephrotomy, 263
Nephrotomy in nephritis, 263
Nerve defects, bridging of, 173
Nerves, final results in secondary sutures of, 186
surgery of, 173
New aids to the surgical diagnosis of diseases of the kidneys and their value, 377

Ochsner, A. J., minimum requirements for aseptic surgical operating in a hospital in which the personnel of the operating-room is permanent, 28
papillary cysts and tumors of the ovaries, 101
removal of shaft of tibia for osteomyelitis, 84
thyroidectomy for exophthalmic goitre, 217
use of the segmented ring in gastric and intestinal anastomoses, 121
Œsophageal stricture, gastrostomy in, 159
Operations for primary carcinoma of the liver, 196
Osteoplastic formation of hard palate, 227
Ovaries, papillary cysts and tumors of, 87
Owens, John E., requirements for aseptic surgical operations, 54

Palate, hard, osteoplastic formation of, 227
Pancreatitis, acute, associated with gallstones, 103
Papillary cysts and tumors of the ovaries, 87
Powers, Charles A., contribution to the surgery of nerves, 173, 195
Pozzi, S., papillary cysts and papillary tumors of the ovaries in consideration with prognosis and treatment, 87, 102

Radium, subtle power of, 253
Ransohoff, Joseph, unavoidable calamities after surgical operations, 290
Removal of shaft of tibia for osteomyelitis, 75
Requirements for aseptic surgical operations, 18, 28
Resection of upper jaws for osteochondromyxosarcoma, 227
Richardson, Maurice H., a case of splenectomy for myelogenous leukæmia, 386
certain rare and unavoidable calamities following surgical operations, 273, 294
gallstones in the common bile-duct, 238
resection of upper jaws, 229
Rixford, Emmet, final results in secondary sutures of nerves, 186
thyroidectomy for exophthalmic goitre, 217

Segmented ring, use of, in gastric and intestinal anastomoses, 111
Spleen, accessory, 220
Splenectomy, case of, for myelogenous leukæmia, 386
Splenomegaly, 220
Stenosis, intestinal, new operation for, 241
Studies in asepsis, 41
Subtle power of radium, 253
Surgery, evolution of, 143
of nerves, contribution to, 173
Surgical operations, minimum requirements for, 18, 28
unavoidable calamities following, 273

Thyroidectomy for exophthalmic goitre, 210
Tibia, complete removal of shaft of, for osteomyelitis, 75
Tuholske, Herman, unavoidable calamities after surgical operations, 291

Ulcer, duodenal, 58

Vaughan, George Tully, operations for carcinoma of liver, 208
treatment of congenital cleft palate, 141

Warren, John Collins, removal of shaft of tibia for osteomyelitis, 85
thyroidectomy for exophthalmic goitre, 218
unavoidable calamities after surgical operations, 295

Weeks, Stephen H., gallstones in the common bile-duct, 232, 240
removal of shaft of tibia for osteomyelitis, 86
thyroidectomy for exophthalmic goitre, 219
What are the minimum requirements for aseptic surgical operations, 18, 28
Willard, De Forest, removal of shaft of tibia for osteomyelitis, 84
requirements for aseptic surgical operations, 52
surgery of nerves, 195